Analysis and Solution Exploration of Design Issues of Group-Form Megastructure

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School of Architecture
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Doctorate Project Committee

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We certify that we have read this Doctorate Project and that, in our opinion, it is satisfactory in scope and quality in fulfillment as a Doctorate Project for the degree of Doctor of Architecture in the School of Architecture, University of Hawai'i at Mānoa.

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ABSTRACT

With the evolution of Megastructures, these ideas remain as utopias that have not taken research to applied practice. They continue to be explored as mere futuristic designs for backdrops in movies, comic books or magazines. These ideals of the mega have progressed toward becoming a reality that exploration of these design issues towards practice is necessary. As non-traditional structures, spatial composition and form symbolizes the creative base for the classic case studies and analyzes the possibilities of establishing various urban space systems

Chapter 1 provides the research background, objectives and methodology. Chapter 2 outlines the history and development of the Megastructure from the Chicago School, the Alger's Plan of Le Corbusier (1930's) to the systematic discussion of Megastructure by Fumihiko Maki (1960's) originated. Chapter 3 defines the Megastructure, its types, Integral-Form and Group Form. Chapter 4 discusses related cases influenced by the Group Form and Megastructures from two possible configurations. By the abstract and transforming of traditional horizontal cities, Chapters 5 and 6 address building the urban space model of the Group-Form Megastructure and lists the design guidelines. Finally, Chapter 7 summarizes the findings that the challenge for current architecture is the adaptive changes of the community's organizational system that is being applied to an aggressive urbanization society.

Key Words: Megastructure, Typology, Group-Form, Space System, Design Guideline,Social Organization

CHAPTER 1 INTRODUCTION

1.1 Research Background

In 1999, Kenneth Frampton's concept of mega-form in the "Seven Points for the Millennium: an untimely manifesto" created the term "megastructure" that made a comeback to the stage of architecture. In Asia, the accumulation and living in the super high-density population in the metropolis has caused a quantity of social and environmental problems such as inferior luminous and acoustic environments. Above all, these problems brought about a sharp increase in the urban population density that it seemed to have transcended to the empirical range of traditional city and modern residential area theories.

According to population estimation, there would be approximately 350 million people migrating from rural to urban China by the year 2020. The price of land would be doubled and through the calculating of horizontal urban growing mode, rapid population growth and the increase in residential density has become an urgent need and reality for China. Since the country has become prosperous, many people want to live comfortable and validate social status through huge construction projects such as CCTV and Shanghai Center and commercial buildings that are built one after another. Due to these traditional architecture designs and knowledge, these experiences have become insufficient to deal with the difficulties that have fast forwarded for faster and larger urbanization in human history. There is an immediate need for new trends. Recent utopian visions from various practices or individuals are clearly figuring out the same thing: Urban megastructures of super high density.

Since the 20th century, the proposals and thoughts from Le Corbusier's "Plan Obus" (1932) to the "Megastructure" by Fumihiko Maki (1961) have resurfaced. The series of ambitious imagination of megastructures by Archigram and Metabolists (1960-70's) shows that chasing the dream of megastructure did not miss a beat. Again, in the last two decades, this ambition was proof that giant skyscrapers continued to be constructed worldwide. In the last hundred years, there were only a few megastructures built. Exploring ways to deal with the difficulty of finding the guidelines for megastructures, the design becomes very important.

1.2 Research Objectives

The first architect who brought the term megastructure into the architectural vocabulary was Japanese architect, Fumihiko Maki. As a member of metabolism, he defined megastructure in his book, "Investigation in Collective Form" and wrote that cities should have

three (3) forms: Compositional form, Meg-structure form and Group form. This composition approval is “a commonly accepted and practiced concept in the past as well and at present.” The proper functional, visual and spatial (sometimes symbolic) relationship would be established on two-dimensional plane.”[1]

Another form is the Group form that some of the basic ideas can be recognized in historical examples of town buildings. Compared to the two other forms, megastructure is based on technology-oriented attitude intending to use technical means to expand the metropolis. It is a utopia answer to the modern metropolis. It wants to create a new pattern to take the place of the old urban pattern. Fumihiko Maki thought the Megastructure “is a large frame in which all functions of the urban or part of the city is housed. It has been made possible by present day technology. In a sense, it is a man-made feature of the landscape. It is like a great hill on which Italian towns were built.”[2] Even in the definition by Fumihiko Maki, the concept was not clear. He quoted Tange’s proposal as “a mass-human scale form which includes a mega-form and discrete, rapidly-changing functional units which fit within the larger framework.”[3]

In 1976, author and British critic Reyner Banham published a book, “Megastructure Urban Future of the Recent Past.” He described the Megastructure as “it is a large framework and it could afford all or part of the urban’s function.”[4] Four years later, Ralph Wilcoxon, Dean of the College of Environment Design at Berkeley prefaced his invaluable megastructure bibliography with an introduction of the word Megastructure and defined the word in four parts:

“1) constructed of modular units; 2) capable of great or even unlimited extension; 3) a structural framework into which smaller structural unites (for example, rooms, houses, or small buildings or other sorts) can be built -or even "plugged-in" or " clipped-on" after having been prefabricated elsewhere; 4) a structural framework expected to have useful life much longer than that of the smaller units which it might support.”[5]

At the University of North Carolina in Charlotte, Associate Professor, Dr. Lin Zhongie thought the Megastructure should be as a: Dominate structure separated from the secondary structure just as the trunk and leaves; while the trunk should be permanent and the leaves could be taking its place. The mega could grow up and it could afford the whole function of the city.

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[1] Maki, Fumihiko. *Investigations in collective form*. St. Louis: School of Architecture, Washington University, 1964.
[2] Maki, Fumihiko. *Investigations in collective form*. St. Louis: School of Architecture, Washington University, 1964.
[3] Banham, Reyner. “Introduction: Dinosaurs of the Modern Movement.” In *Megastructure: Urban Futures of the Recent Past*,7-12. San Francisco: Harper & Row, 1976.
[4] Banham, Reyner. “Introduction: Dinosaurs of the Modern Movement.” In *Megastructure: Urban Futures of the Recent Past*,7-12. San Francisco: Harper & Row, 1976.
[5] Banham, Reyner. “Introduction: Dinosaurs of the Modern Movement.” In *Megastructure: Urban Futures of the Recent Past*,7-12. San Francisco: Harper & Row, 1976.

In 1969, Paolo Soleri, Italian Architect and Urban Planner, brought forth archology, the study of arconsanti that combines architect and ecology. He experimented with trying to develop a miniaturize city to fit the height and density in the smallest area, containing the maximum population and creating a harmonious inhabitation environment for people. In recent years, Soleri built a mature Megastructure prototype that has a height of one thousand meter in the tower complex building and spans over an area of about one square kilometers. The residential area of urban layout was located in the complex surface while the public buildings were concentrated in the complex building. All the functions of the urban were highly compact to minimize the consumption of land space, energy and resources. Architects should also consider the energy efficiency and the development of new energy sources, to reduce dependence on conventional energy resources. Paolo also produced a quantitative standard for a building that is one square kilometers and the FAR= six (6) to accommodate 100,000 people. In recent years, the Beijing Vantone Real Estate Company used this standard with their Vertical Urban projects in China.

1.3 Research Status

There is a rich research resource on the Megastructure in the world. Developing the mega into the human living appeared after the First World War. The concept was created by architect, Le Corbusier, the creator of modern architecture and urban planning. One of the earliest exploration of the Megastructure was built in the 1930's: Cob's "Algiers City Plan A". It was designed with an elevation of 100m from the highway and located in the cliffs that arranged for 180,000 residents to live.

Archigram is an avant-garde architectural group formed in 1960's by a group of young London architects. These British architects designed the "Plug-in City" with no buildings but a massive framework for dwellings reflecting the mega city that could be slotted. Italian architect, Paulo used archiology as the base for the exploration of the true sense of the mega city practice.

In December1976, Reyner Banham published the "Megastructure", a book presented for the first time in the monograph publication introducing the Megastructure movement and the development of the megastructure academic significance. This book is well recognized as the most important and valuable monograph by many theory researchers on Megastructure study.

In October1979, "Architecture and Utopia: Design and Capitalist Development" was published by Manfredo Tafuri. He introduced the utopian idea of building a city that was designed and practiced as different Utopia and architecture related to the city. In 1986,

Manfredo Tafuri and Francesco Del Corral wrote a book called, "Modern Architecture ". Through their writing in chapter 20, they devoted “The International Concept of Utopia” on mega structure that was introduced during this period of history.

In1999, Kenneth Frampton presented a report on the "Seven points for the millennium: an untimely manifesto" at the 20th International Association Conference. At this forum, Frampton introduced a new academic concept on mega form and explained the relationship with the Megastructure and provided continuity of the megastructure in contemporary architectural design and theory. MVRDV architects also wrote 2 books: “FAR MAX” in1998 and “KM3” in 2006 that was based on the summary of the design and theory concerning the density and spatial development strategy. As an important member of metabolism, Arata Isozaki wrote a book, “Uncompleted / Reverse Architectural History" that introduces its individual anti-architecture theory and project from the view of the Megastructure movement. In July 2005, Simon Sadler published a book, called “Archigram “and introduced Archigram as an academic and practical development.[6] In 2005, the University of Hawai‘i at Mānoa and Tongji University published “Asian Mega-Projects”. Since then, Tongji University did a series of design studios on Megastructure by exploring the modern Megastructure practice and combining t with the new technology. Lin Zhong Jie , associate professor of the University of North Carolina published a series of articles on metabolism and explained the relationship between metabolism and Megastructure. After 2011, the National University of Singapore held the forum and competition on "Asia Vertical City".

Prior to 2005, research on Megastructures was limited. However, in 2005, Yin Huiling wrote her master thesis on *" Research of Megastructure between 1950s and 1970s---Achigram"* and first to use the Chinese translation of “Megastructure” in Nanjing University and introduced the development of Megastructure as Archigram. In 2008, Qili, master of architecture in Southeast University, first summarized the theory of Megastructure in his thesis “Megastructure Movement: Design Strategy of Contemporary Architecture”. At the same time, Wuliang, a student of Harbin Institute of Technology, wrote a thesis, "*Study on Group Tall Buildings on the Philosophy of Symbiosis*". In this paper, it explored the Megastructure form as a form of a group high-rise buildings. Recently, Tongji University started to research the topic of Megastructure. Huang Yiru, Zhu Peidong published the article" Megastructure: Evoking Dream for Future". Yao Dong and Huang Yiru also published an article " ‘Megastructure ’ Megastructure of 100

[6] Qi,li.*” Megastructure and Influence to Modern Architecture”* Master Diss., Southeast University,2009.

000',Studio Course and Reflections". Dai Songhua published the article" *Residential Limitless: Megastructure for Life or Subsistence"*. All of these were based on the design studio teaching practices. Professor Dong Chun Fang published a book, "*Architecture to High density* ". In chapters 3, he wrote on the high density characteristic of Megastructure. The Vantone Group, a Chinese real estate company, set up a specialized company in the Vertical City. In 2009, this Group was associated with a number of domestic and international architecture studios that have experiences in high density residences and was able to put the research into practice. This Group also invited AS+GG studio to participate on a project that planned to build a vertical city with 6 million square meters area and 100 to 150 thousands population in 1 ha. In Changsha, the Broad Group launched their design competition on Sky City Phase I in 2010. This project declared to build 200-stories and 666 meters on the megastructure that will cover an area of 1.24 million square meters and population of 100,000.

1.4 Purpose and Significance of the Research

Presently, the domestic and foreign research achievement on Megastructure mainly concentrated their development on the Megastructure movement. It researched the theory but lacked the real practice of construction. This thesis attempts to sort the development of the megastructure based on the domestic and foreign research results, combining domestic and foreign relevant high density cases and large-scale construction. This thesis will also explore design strategies to help the megastructure become a reality in construction

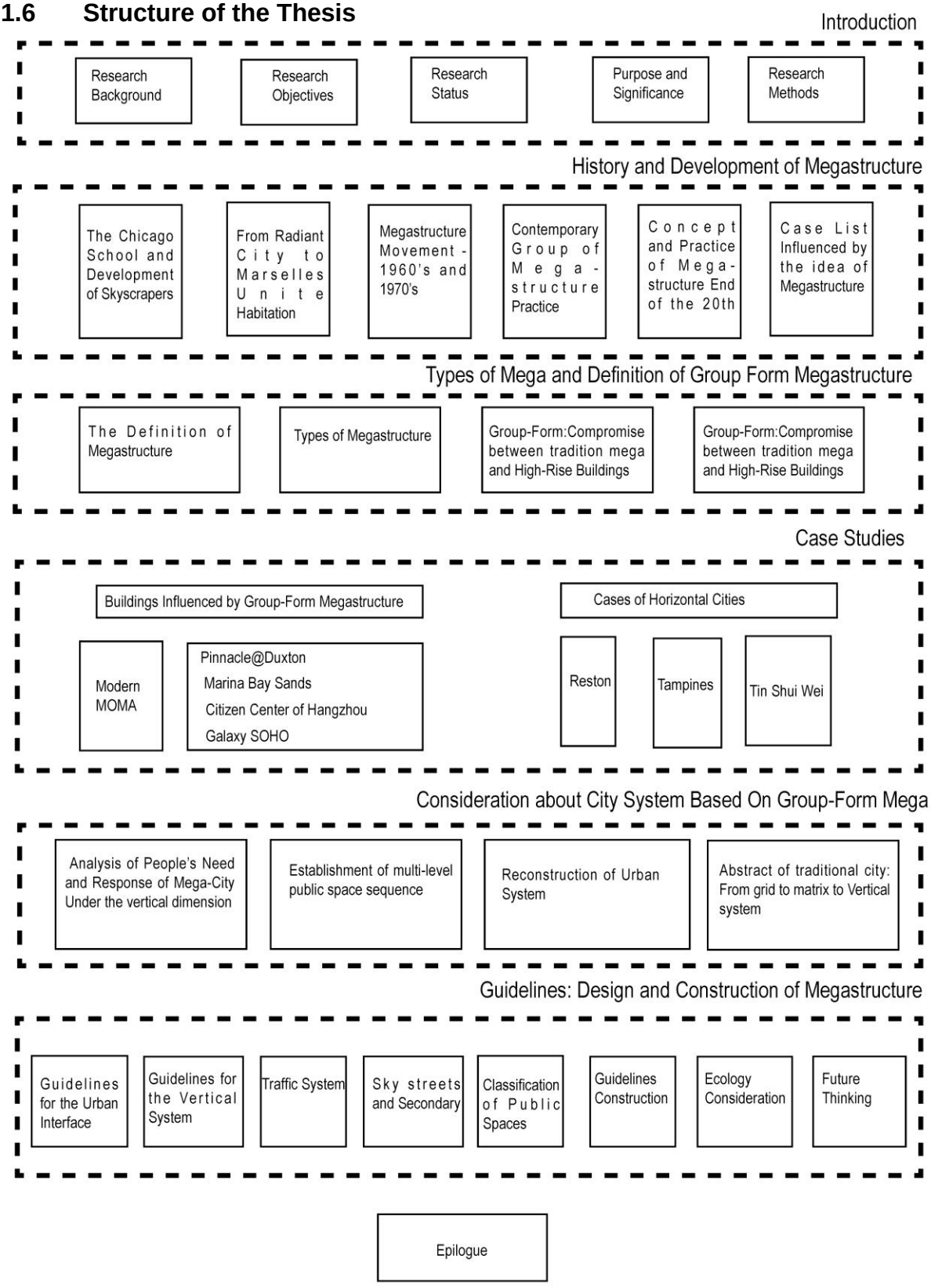
1.5 Research Methods

The Theory Research: Conduct the research on theory relating to high density community, Megastructure, and traditional urban planning theory.

The Case Studies: Case study researched will provide comparisons or relationships between the super high-rise structure on construction such as the Vantone "Great City" , the Broad Group, "Sky City", and case studies on high density in Shanghai, Hong Kong and Singapore.

Others: Data Analysis, Diagram Analysis.

1.6 Structure of the Thesis



CHAPTER 2 HISTORY AND DEVELOPMENT OF THE MEGASTRUCTURE

2.1 The Chicago School and Development of Skyscrapers

What is Megastructure? In the traditional ideas, it is a huge scale building or construction. This may be difficult to define but visually some of the examples are the Great Wall and the Egyptian Pyramids that can be seen as the early Megastructure. With the development of construction technology and the emergence of the skyscraper, the Megastructure had the potential to be built.

The American modern architecture was founded at the Chicago School. In 1871, the Chicago fire destroyed almost all the wooden constructed buildings in the city. In order to save the land during reconstruction of the city, the government required architects to increase the Floor Area Ratio (FAR) to create additional space. With the emergence of new construction technology such as the metal structure, curtain walls and the supporting structural system, this knowledge helped to solve the construction problems. The fire prevention system and safety evacuation technology gradually increased the safety programs for the public. During the 1860's, the drainage system, lighting system, steam heating system and a steam engine ventilation system appeared while the air conditioning system appeared in the 1920's. Another important element that emerged was the elevator that a buildings' limit of the 5 floor height rule. All of the above factors contributed to the birth and development of high-rise buildings that led to the modern high-rise buildings that began to emerge in Chicago.

One special building that was designed by William Le Baron Jenny was the Home Insurance Building that was built in 1885 (Figure 2.1). Built with 10 floors, it was the first high-rise building constructed as a modern steel frame structure. In the1900's, the Flatiron Building by Daniel Burnham architect, reached a height of 87 m and became the landmark of New York at that time (Figure 2.2). The Woolworth Building designed by Cass Gilbert reached the height of 243.8 m which was the highest building in 1913. However, the most famous skyscraper appeared in the 1930's and was called the Empire State Building (Figure 2.3). The Empire State Building is generally thought of as an American cultural icon. It is designed in the distinctive Art Deco style and has been named as one of the Seven Wonders of the Modern World by the American Society of Civil Engineers. It could be a symbol of the American Empire and as well as part of the American public culture.

Figure 2.1 Home Insurance Building

Figure 2.2 Flatiron Building

Figure 2.3: Empire Building

Before the invention of elevators, it is believed that "all the floors that were higher than the 2nd floor could not be used for businesses and all of the floors which were higher than the 5th floor cannot be used for residence."[7] Even before the emergence of the steel structures, buildings like the Monadnock Building in Chicago that was built 1893 used the brick structure system and reached a height of 16 floors. This was the tallest building of that time. The new steel structure technology allowed architects to escape the limit of gravity and expand the space in the vertical direction. Many architects created many unimaginable designs and came up with many ideas on future cities.

In March of 1909, A.B. Walker described the future City of Fantasy as the elevator connected 84 floors in a single vertical transportation. In the early nineteen century, Kansas architect, Theodore Starrett was a pioneer builder of skyscrapers who designed and built a100-floor building that was an example of the early vertical complex. For every 20 layers, each level had different functions such as residence and business. Public spaces such as parks and theaters were inserted in the space between every level. [8] This concept took on the character of mega. Because of the Chicago School and skyscrapers, architects, builders and designers started to break away from the traditional pattern and designed with many ideas that eventually led to the emergence of Megastructure movement.

[7] Koolhaas, Rem. *Delirious New York: a retroactive manifesto for Manhattan*. New ed. New York: Monacelli Press, 1994.

[8] Dong,Chunfang. *Architecture to High Density.* Beijing: China Architecture & Building Press,2012.

2.2 From Radiant City to Marseilles Unite Habitation

As a pioneer of modern architecture, Le Corbusier also founded the modern Megastructure movement. He introduced the concept of the Radiant City for three million residents. The vehicle and pedestrian system could be separated allowing the high-rise building to open up the land as much as possible and gardens in the air created an artificial "secondary ground". Although the Radiant City was an exploration for a future high density city, Shanghai and Hong Kong used this model and it has become a reality, but the concept cannot be equal to Megastructure although some thought it had the ideas of Megastructure.

The Algiers Plan has been regarded as the first "real" Megastructure (Figure 2.4). In 1930, the concept of a new city design stood 300 feet off the ground and more than 19,685 feet in length. While 15 layers of the secondary ground where people lived was built under the road. A highway stretched along the Bay and 6 layers were set under the road and 12 layers set above the pavement (Figure2.4, 2.5). Each layer of the secondary ground provided ample height to build any style of residential units.

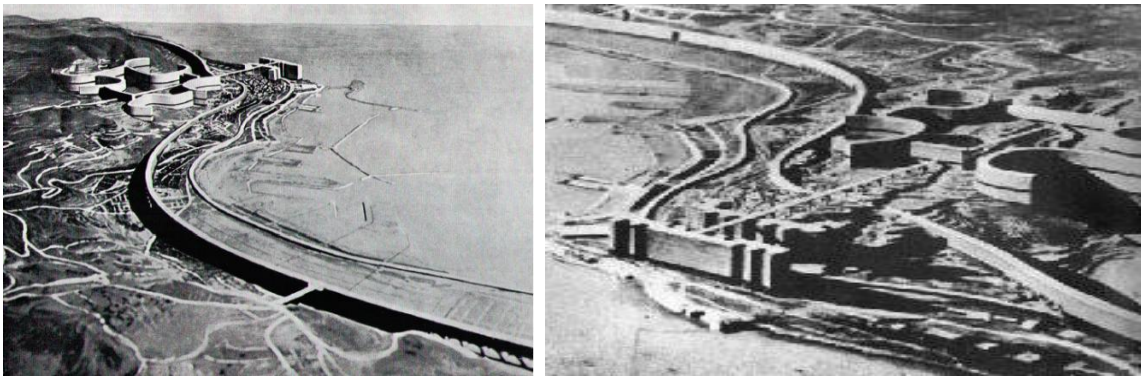


Figure 2.4.,2.5: Perspectives of Algiers Plan A

Comparing the two former building, the Marseilles Unite Habitation's is not large in scale but it is very important for the development of mega because it reflected Corbusier's Future City's idea (Figure 2.6 & 2.7). The Marseilles Unite Habitation, a small vertical city like apartment located in Marseille, France was built after the Second World War between 1947 and 1952. It proved to be very influential and is often cited as the initial inspiration for the Brutalist architectural style and philosophy.


Left: Figure 2.6：Le Corbusier, Unité d'Habitation, Marseille ,1952.
Right:Figure 2.7：First Floor of Unité d'Habitation, Marseille,1952.

Designed and built with 18 floors, there are 23 different units fit the different family structure from single individuals to a family of 10 memebers. There are 337 units that could be available for 1500-1700 person. Throughout the building, the interior stairs allow for 2 floors become one large public space.

The Marseilles Unites Habitation reflects the simple ideas of Megastructure. It is not only for residents but also has a mixed-use function. For instance, on the 7th and 8th floor, there are commercial shops and public facilities, including restaurants, hotel and other service facilities. The children's kindergarten school is on the roof that is connected to the roof garden by a ramp as well as a swimming pool, games, a racetrack and other activities. In the design, the architect visualize the roof garden like the deck of ship that can allow visitors to enjoy the outdoor activities and the surrounding beautiful scenery[9].

From this apartment, guidelines began to emerge about Megastructure.

1. Diversity of functions: Not only a residential building but included entertainment, leisure, school, functional indoor Streets, etc. to meet the daily life of people;

2. Open bottom space to the public: It is similar to one of Five Points of Modern Architecture where the open bottom space was for the public that connected the people creating a stronger city stronger while providing more public spaces and reduce the crowd.

3. Vertical public space: The 7th and 8th floors of the apartment were used as a public street. The use of the roof also satisfied the need for public activities.

[9] Zhang, Caihong and Hang Ma."Visiting Marseilles Unite Habitation Again."*HuangZhong Architecture*(2003):28-30.

4. Modular: The architectural design used several different modular systems to satisfy different groups and activities.

2.3 Megastructure Movement: 1960's-70's

2.3.1 Summary of the Megastructure Movement

Le Corbusier conducted a very important exploration of the Megastructure and then, it fell silent for a long time. The prosperity of Megastructure was in 1960-1970 when the method of modernism could not make sense in facing various problems in the development of modern cities. Many architects and planners desired to change the solutions and hoped to place all the functions into one big building. The trend of centralism city was their direction. During this period, many groups were developed such as Team 10, GERM, Metabolism and Archigram.

In the early 60's, a large number of representative organizations and individuals emerged in the Megastructure movement that gradually entered a mature stage. These organizations and individuals included: the metabolism such as Tange Kenzo in Japan, British architecture group Archigram and Super Studios in Italy. Meanwhile, in United States, Paul Rudolph put forward the design of "Graphic Arts Center" and "Ford Foundation" in New York[10], and both of them are influenced by the megastructure. For these young architects, Megastructure was a revolution for the traditional architectural style. They hoped to be able to be the pioneers of modern architecture and design the same for the finished city environment changes brought about by the utopia.

The development of this Utopian is the same with the social ground. At that time, the popular musical group, the Beatles and Superman were very popular in society which was an anti-authority and anti-traditional culture. The social trend of thoughts influenced the field of architecture and city planning. These architects wanted to change the city with a kind of heroic spirit, hoping to be able to solve the problems with traditional messianic and more radical means. This was the ideal form from this batch of pioneer eyes. At the end of the 1960s and with the era of the Vietnam War, anti-war thoughts reached its climax reflecting films as the popular culture. The film "Blade Runner", the future of Los Angeles city was designed to be composed of several Megastructure that showed a huge architect's imagination in the film. The worship of technology

[10] Rudolph,Paul, and Yukio Futagawa. *Paul Rudolph: dessins d'architecture : Architekturzeichnungen : architectural drawings*. New York: Architectural Book Pub. Co., 19811972.

oriented and unlimited energy created a good means of superstitions in vertical city great as it tried to solve the problems of city developments in the future.

2.3.2 Metabolism

In 1960, a group of talented Japanese architects including Kiyonori Kikutake, Kisho Kurokawa, Fumihiko Maki and other came onto the stage of architecture in the Tokyo World Design Conference. Their ideas came from organic biological growth and influenced the form of concept of the Megastructure. “It had its first international exposure during CIAM's 1959 meeting and its ideas were tentatively tested by students from Kenzo Tange's MIT studio. They were influenced by a wide variety of sources including Marxist theories and biological processes. Their manifesto was a series of four essays entitled: Ocean City, Space City, Towards Group Form and Material and Man, and it also included designs for vast cities that floated on the oceans and plug-in capsule towers that could incorporate organic growth. Although the World Design Conference gave the Metabolists exposure on the international stage their ideas remained largely theoretical.”[11]

As an islands country, Japan's land and resource is limited and in the 1960’s, the economy and population of Japan boomed and needed large parcels of land and public facilities, and it is part of the reason why metabolism originated in Japan. They claimed Metabolism is the name of the group, in which each member proposes further designs of our coming world through concrete designs and illustrations. They regarded human society as a vital process - a continuous development from atom to nebula. The reason why they use such a biological word, metabolism, is that “we believe design and technology should be a denotation of human society. We are not going to accept metabolism as a natural process, but try to encourage active metabolic development of our society through our proposals.”[12] The metabolism brought forth different solutions to the development of modern cities such as Tokyo’s “hopelessly" (Isozaki' words) situation while Arata Isozaki introduce the concept of the City. Compared to Cobb's "Radiant city", Arata Isozaki retained the city of Tokyo and kept several core tubes, including the vertical transport and other infrastructure that supported the myriad as a small box office to form the new city in the sky. In the "Tokyo Bay plan 1960" designed by Tange Kenzo, he envisioned that the city could be the linear development, like a life extension growth, while maintaining an organic whole. Kiyonori Kikutake came forward with the concept of the sea city for the

[11] “Metabolism(architecture)”, accessed by May 7th,2014. http://www.docin.com/p-637558296.html

[12] Li, Zhongjie. *Kenzo Tange and the Metabolist Movement: Urban Utopia of Modern Japan*. Beijing: China Architecture & Building Press, 2011.

Japanese land limited problem. Kisho Kurokawa wrote about four planning proposals in his essay" Space City": 1) the new planning of Tokyo, 2) the wall of the city, 3) city agriculture and 4) the mushroom house. In his thinking about agricultural city, the architect Kurokawa discusses that the future city should eliminate the contradiction between city and countryside. Each city was built on a concrete slab 500*200 meters. The bottom of the main building was overhead so that all the earth could be used as agricultural production (Figures 2.8-11).

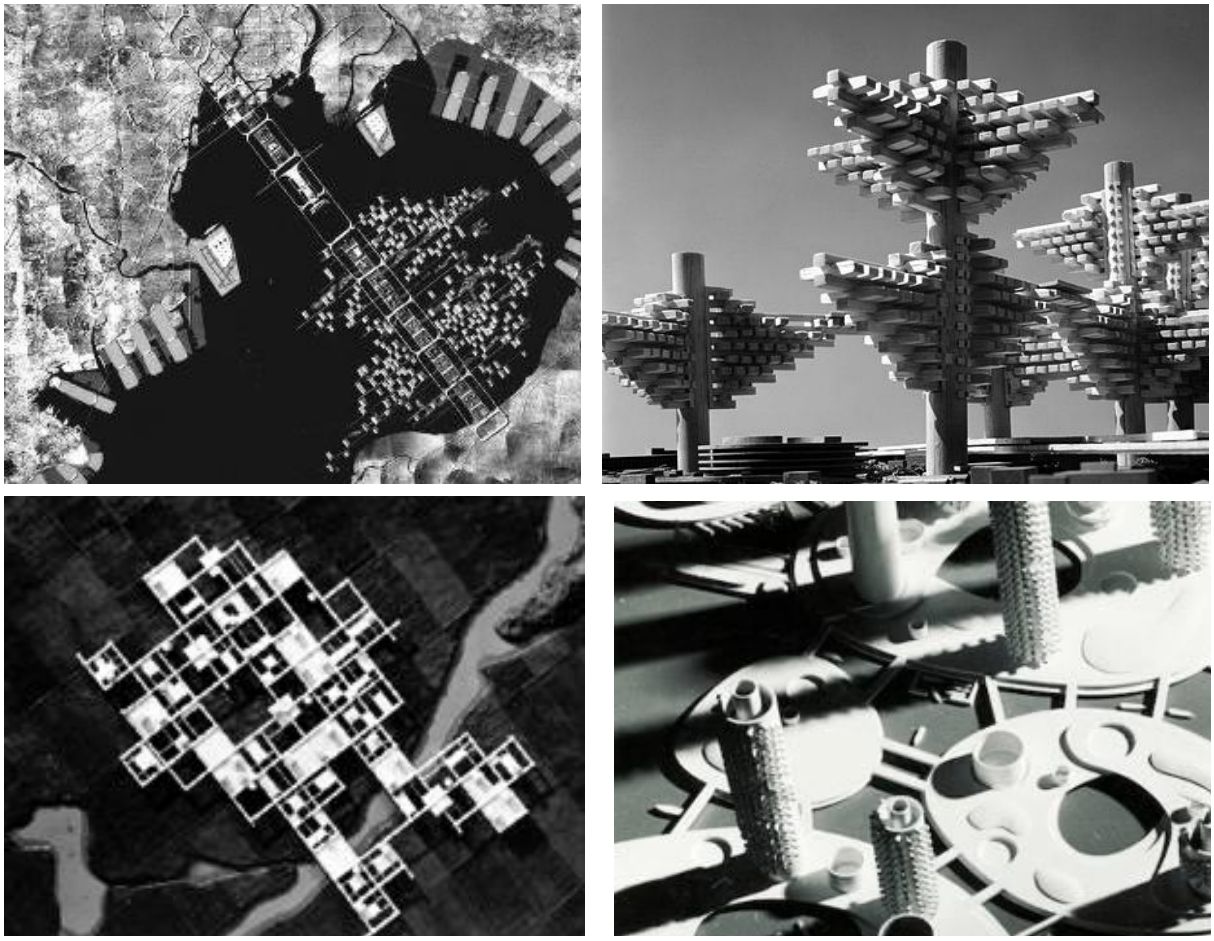


Figure 2.8（top Left）: Tokyo Bay, Kenzo Tange,1960. An urban structure extending downtown Tokyo some eighteen kilometers across the bay, and filling much of the remaining area of water with associated housing structures. Like Gruen's Fort Worth, it raised the threshold of credibility for urban planning projects, but put traffic works to entirely new uses in creating form(each sub-district of the scheme is framed in a loop of freeways), and thus made Japan the fount of inspiration for architectural and urban visionaries for most of the sixties.[13]
Figure2.9(top right): City in the air, Arata Isozaki,1961.
Figure2.10(bottom left): Agriculture City, Kisho Kurokawa,1961.
Figure 2.11(bottom right): Ocean City, Kiyonoru Kikutake,1962. vast cylindrical towers forming the "trees" on which the individual dwellings come and go line seasonal "leaves", each according to the natural time-scale of its own

[13] Reyner Banham, *Megastructure: Urban Futures of the Recent Past*（San Francisco: Harper & Row, 1976）, 52.

proper ‘metabolism’, and all standing of floating concrete islands in order to relieve the pressure on Japan’s scarce supplies of urban land.[14]

It is noted that the buildings in Japan are always "temporary" because of the long-term earthquakes. Traditionally, many of the important buildings in Japan are regularly updated. One of Japan's most important building is the Ise Shrine that is repaired every 20 years while in China and Europe construction is "permanent" (Figure 2.12).

Figure 2.12: Periodic Renewal of the Imperial Grand Shrine (Shikinen Sengu) in Ise, Japan, meaning its ritual rebuilding every 20th year.

Traditionally in China and Europe, building renewal is often passive and usually often due to war or other causes structural damage to take measures. But in Japan, building renewal has strong origins and is one of the reasons for the metabolism movement happening in Japan. The metabolism has an important role in the Megastructure movement. Compared with other groups, the metabolism about future cities cannot free the trace of Utopia but architects whether consciously or unconsciously created the strategies on Megastructure that helped the development of Japanese architecture. The idea of Tange Kenzo predicting the change of Tokyo is reflected in the Fuji Television Headquarter where the focus is on the vertical public space. The Shizouka Press and the Broadcasting Center can be seen as a small scale air city that is elaborated, constructed on land more than 189 square meters with a triangle. In this harsh land, the architect designed the office building with a total area of 189 square meters and a height of 57 meters. This space has provided a well-off floor space as the city opens to e space, volume rate of 7.9. In addition, the Capsule Tower of Kurokawa and the Group idea of Fumihiko have deeply influenced the Megastructure.

[14] Reyner Banham, *Megastructure: Urban Futures of the Recent Past*（San Francisco: Harper & Row, 1976）, 46.

Figure 2.14-15： Shizouka Press and Broadcasting Center

2.3.3 Archigram

In the 1960's, the Archigram Association was founded in the city of London. Meanwhile, the Beatles was so popular in American and Europe that the youths doubted the traditional brief values. They rebelled by letting their hair grow long and by wearing unusual clothing. Their dissatisfaction was strongly expressed in music like "Against the traditional value" became so popular in that time that is also led to the movement.

They focused on the future and they were anti-heroic. They wanted to solve problems and create new city patterns by developing high and sophisticated technology. The main members of the group were Peter Cook, Warren Chalk, Ron Herron, Dennis Crompton, Michael Webb and David Greene. In 1963, they conducted an exhibition called the Living City and published their Journal called Archigram. In their ideas, the city and building could be moveable admitting that freed the property forever. Compared to metabolism, their ideas were nearly utopia except that Kunsthaus Graz, designed by Peter Cook, 2003 collected all of their ideas and not built the buildings. However, their ideas about the Megastructure and future cities took an important position in architecture's history.

Cook designed the Plug-in City between 1962 and 1964. "This provocative project suggests a hypothetical fantasy city containing modular residential units that "plug in" to a central infrastructural mega machine. The Plug-in City is in fact not a city, but a constantly evolving Megastructure that incorporates residences, transportation and other essential

services–all movable by giant cranes”[15] (Figure 2.16). In the ideas of Cook, people could plug new units and remove the old every 20 years. These crazy ideas broke the concept that the building must be solid, liberating the city from the limit of geography. Ron Herron’s ideas of the "Walking City” is more like a robot than a building. The form came from the combination of insects and machines and literally an interpretation of Corbusier's aphorism of a house as a machine for living in (Figure 2.17). The pods were independent and they could plug into way stations to exchange energy and resources. It is regarded as a residence form to live for the future.

In 1969, Cook and Herron brought their ideas on the "Instant City" that focused on mobile technology via air (balloons) with provisional structures. It produced a mass culture with an embrace of advertising aesthetics. The main philosophy of Archigram is mobility. They wanted to make the city to obtain a nomadic possibility and give up the chance as an eternal monument. Since the traditional city pattern and architects did not focus on the practice and it disappeared after 1974.

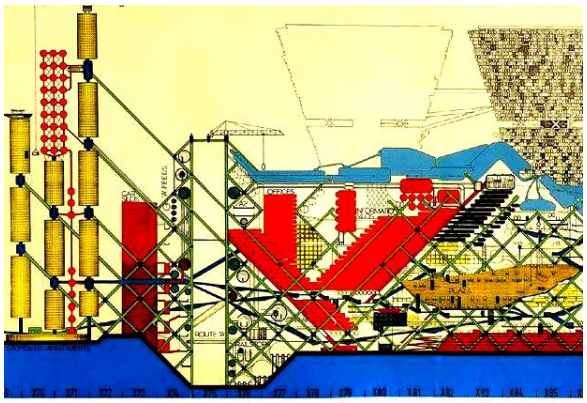


Figure 2.16 ： Plug-in City

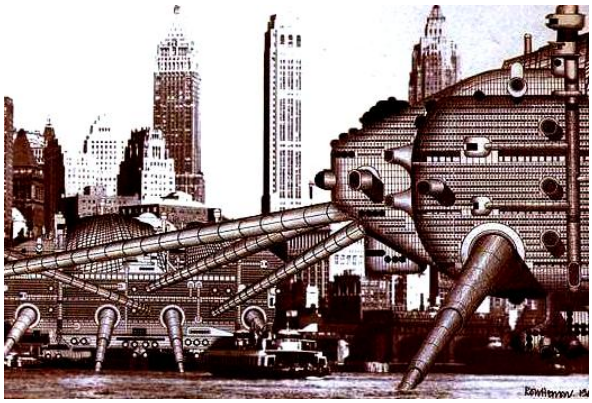


Figure 2.17 ：Walking City

2.4 Contemporary Group of Megastructure Practice

As an active architect, Rem Koolhas published, Delirious New York and wrote that "the City is an addictive machine from which there is no escape".[16] Koolhas acknowledged that was influenced by the Metabolism Movement. In his works, we find the idea of Megastructure, such as Seattle Central Library, Villa Dallava and especially CCTV who broke through the traditional pattern of Skyscrapers, to find the available space in the vertical direction.

[15] “AD Classics: The Plug-In City / Peter Cook”,accessed May 7th,2014. Archigramhttp://www.archdaily.com/399329/
[16] Koolhaas, Rem. Delirious New York: a retroactive manifesto for Manhattan. New ed. New York: Monacelli Press, 1994.

MVRDV also focused on the Megastructure. In their publication, KM3 explained their ideas. They researched the function of city and find how to take 1800 square KM and create a space into a cube of 38 cubic KM. In the second half, they designed a "Pig City" that provided a Group-Form high-rise buildings for pigs as well as a recycle system for the whole city.

They focused on the research of density and combined it into practice providing useful experiences. In Hannover Expo Pavilion, they created different urban functions in a building in the vertical dimension of stratification. This was a reconstruction of a three-dimensional space in a crowded urban space to create the air courtyards, pavilions and air space forest.[17] In Spain, the MIRADOR housing, they transferred the block into a vertical direction, shaping the diversity of air public space.

In 2011, their design of the “China Mountain" can clearly be seen as Megastructure for a future design. Assuming that 1 * 1 * 0.5 km can accommodate a range of 100,000 inhabitants, the city would have many piles of peaks looking like high-rise residential areas throughout the city and the "mountain" representing the internal housing that is the commercial, industrial, recreational and other spaces.

Canadian -born Israeli architect, Moshe Safdie also studied large-scale urban studies. In 1967, Dwelling 67 was his modular construction for the city’s attempt to design the Sands Hotel in Singapore. Safdie was able to join the air through the formation of a dynamic roof air plaza.

In recent years, architect Steven Holl became quite active in the field of the Megastructure. Modern MOMA and Vanke Center can be seen as his attempt for the giant structure but it was Modern MOMA that broke away from the traditional concept of Megastructures. Through the sky corridor, the groups of buildings for the city's complex functional and spatial three-dimensional combination was built, integrated and used. This was viewed as the constitutive theory and practice discovered in recent years and a giant breakthrough. The Vanke Center is a "horizontal skyscraper" that was fully released to the urban space. Finally, Japanese architects Hiroshi Hara, Shinji Harada Lang and British architect, Norman Foster also have been trying to construct Megastructure from a different perspective.

[17] Dong, Chunfang.”Architectural Tactics in High Density” *Architectural Theory*(2010):20-23.

2.5 Concept and Practice of Megastructure Since End of 20th Century

At the end of the 20th century, the Megastructure came to a new development compared to the utopias in 1960's -1980's. These new ideas have the possibility to be built. For instance, the Millennium Tower is 840 meters that has a conical shape and was developed into a small vertical Town with a hotel, shops, apartments and offices. The building is 170 stories high that accommodates 60,000 people. At each section of the building mass between the vertical public spaces is a community center. The Millennium Tower is divided into a number of vertical communities and at the same time refuge layers exist. The community maintains an independent operation and meets the various needs of the vertical system (Figure 2.17).

Figure2.17: Millennium Tower 1989 , Norman Foster Height：840m .Conceptual Design.

Figure 2.18: TRY2004 Mega-city Pyramid, Shimizu,1991, Height：2004m.Conceptual Design.

Norman Foster designed a high speed traffic system that accommodated 160 people. The speed was two times faster than the traditional one. The elevator stopped on all 30 floors. The five story atrium center has a different function that could be a hotel as well as a department store. Connections between at every second layer, the balcony and garden created a communal feeling. The wind turbine of the Millennium Tower and installation operated on a solar battery board for the upper entire buildings to provide sustainable energy. This is the ideal city design scheme and one of the most environmentally friendly present.

At the conceptual design, Shimizu Japan also proposed a mega city concept built Pyramid that the whole city could accommodate 750,000 people and up to 2004 meters (Figure 2.18).

Through the design with new materials and natural light, a self-circulation of resources and energy can be realized.

Located in the capital city of Moscow, the "Crystal Island" (Figure 2.19)will have 900 apartments and 3,000 rooms of hotel that could satisfy the need for 30000 people. At the same time," Crystal Island" will build an international school for 500 students studying and providing amenities like cinemas, museums, theaters, hospitals, stadiums and dozens of shops. The "Crystal Island" will also contain Moscow's largest public space on the ground of 300 meters high. Norman Forster will build on an area of more than 1 square meters of the "airborne", 360 degrees omni bearing Moscow beauty to residents and tourists. While the "Crystal Island" bottom is filled with large gardens and parks, it is also available for residents of cross-country skiing and skating in the winter. Developers had built a 16,500- parking spaces for the super large underground parking lot.

Figure 2.19:
Crystal Island
Designer: Norman Foster
Height：457m
Area：2.5 million square meters
Residents：30000 people
On construction

During this period, Japanese architect Harada Jinro also proposed the concept design of vertical Mega City -Tokyo Air City 1000. He was hoping to form the overall design by vertical stacking 14 layers of space plateau including vertical layout of residential housing, schools and other public facilities. In 1986, Koolhas proposed the Hyper Building design in the city of Bangkok. The Utopian construction covered a building area up to five million square meters that accommodated residential education welfare and other public facilities. With six different speed elevators as an ultra-building vertical contact, there was also a 12 km long pedestrian street from the ground to the top of Megastructure. Due to the intensive use of the land, the interest for Megastructure with the government and the developers was gaining popularity. The domestic research and practice on the construction of the unprecedented was active. Vantone Group planned to build "three-dimensional city" project in Hebei Langfang, Chengdu Shuangliu, Zhejiang Wenzhou and Shaanxi Xian. The total area of the four vertical cities is 14.59 square

kilometers. In Chengdu, the vertical city covered an area of one square kilometer and the total construction area is six million square meters. The developers held a series of "Vertical City" exhibitions. From these exhibitions, we could notice that Megastructure has become one of the options to realize vertical city (Figure 2.21).

Figure 2.20：Skyline City. Designers: Wang Meng, Li Yichun, Yang Zhijiang. Advisors: Huang Yiru, Yao Dong.

Figure 2.21: Urban Stage. Designer：Han Lebin, Ding Kai, Li Jun Advisors：Huang Yiru, Yao Dong.

MVRDV also participated in the exhibition and the design "China Mountain" looks like a full terrace tower. The outside sunshine terrace is adequate for human habitation, agriculture and

energy production. The Tower design has a large cave with no sunshine and could be used for water storage or as a warehouse, commercial, leisure, entertainment or other activities. The designers are planning a scientific and reasonable approach to the city traffic. The public facilities and employment allocation within walking distance is anxious to develop public transportation to reduce the dependence on the car trip.

Figure 2.22: China Mountain, Vertical City Exhibition. Designer: MVRDV.

In the imagination of the Utopia, the ecological technology consideration has been an important part. The architects hope to combine the ecological technology and a higher density of architectural form to create livable spaces and save energy resources on future cities. Paul Solerio's Arizona's construction is the first exploration, of the ecological city of fantasy that stayed in the realm of fantasy due limited resources and many other factors. In recent years, the support of oil in the Middle East made the imagination of the Utopia possible. Together with the government, the investment company of Abu Dhabi and the United Arab Emirates started to build Masdar Eco City in 2008. They were

Figure 2.23：Perspective of Masdar
Designer： Norman Foster

expected to invest 2.2 billion dollars for project that was to cover an area of 6 square kilometer and expected to accommodate 50,000 people. The government's expectation was become a high density and zero carbon sustainable development. Through the construction of the natural shade ventilation that would help reduce the energy consumption and the use of new technology, larger-scale solar panels was able to achieve self-complementary energy.

2.6 Cases List influenced by the idea of Megastructure

	Name	Designer	Year	Status	Classifaction	Image
1	100-Floor Building	Theodore Starrett	1906	Concept	Integral-Form	
2	Utopia in Air	A.B.Walker	1909	Concept	Intergral-Form	
3	Radiant City	Le Corbusier	1922	Concept	Group-Form	
4	Wolkenbuge	El Lissitzky	1924	Concept	Intergral-Form	
5	Algiers Plan	Le Corbusier	1930	Concept	Intergral-Form	
6	Marseillers Unite Habitation	Le Corbusier	1952	Built	Intergral-Form	
7	The Spatial City	Yona Friedman	1958	Concept	Intergral-Form	
8	Tokyo Bay 1960	Kenzo Tange	1960	Concept	Intergral-Form	
9	Cities in Air	Isozaki Arata	1960	Concept	Group-Form	
10	Cities on Sea	Kiyonori Kikutake	1962	Concept	Intergral-Form	
11	Agriculture City	kurokawa	1962	Concept	Intergral-Form	
12	Yamanashi County Cultural Center	Tange Kenzō	1967	Built	Intergral-Form	
13	Shizouka Press and Broadcasting Center	Tange Kenzō	1967	Built	Intergral-Form	
14	Habitate-67	Moshe Safdie	1967	Built	Intergral-Form	
15	Capsule Tower	Kurokawa	1972	Built	Intergral-Form	
16	Millennium Tower	Foster	1989	Concept	Intergral-Form	
18	Mega-city Pyramid	Shimizu	1991	Concept	Intergral-Form	
19	Hyperbuilding	Koolhas	1996	Concept	Intergral-Form	
20	Shin Umeda City	Hiroshi Hara	1993	Built	Group-Form	
21	Beijing Modern Moma	Steve Holl	2003	Built	Group-Form	
22	CCTV	Koolhas	2004	Built	Group-Form	
23	Marina Bay Sands	Moshe Safide	2010	Built	Group-Form	
24	Hangzhou Civic Center	Li Linxue	2009	Built	Group-Form	
25	The Pinnacle@ Duston	ARC studio	2010	Built	Group-Form	
26	Yinhe Soho	Zaha Hadid	2010	Built	Group-Form	
27	Vertical City	Vantone Company	2010-	Process	Group-Form	
28	Changsha Air City	Broad Group	2011-	Process	Intergral-Form	

Table 2.1:Classification of some megastructure’s concepts ot practices in the history. Source: done by Xu Yang.

Table 2.1 lists the classification of megastructure’s concepts or practices influenced by relevant ideas. It should be noticed that, though part of built cases are not “real” megastructures, they could still be regarded as Group-Form or Integral-Form form perspective of configuration

2.7 Summary of chapter

In the past hundred years of the Megastructure's development and under the leadership of generations of architects, the Megastructure has provided many experiences and design processes. From the Chicago School to Le Corbusier, the metabolism, Archigram and Koolhas, MVRDV, numerous great architects have explored their practice and thoughts. Unfortunately, most of the case studies are only designs on paper but the design is just the exciting imagination of what is to come and apply practice. The word of "Megastructure" is always connected with "Utopia" but what is hindering is toward the final practice. How does the idea "Megastructure" from "Utopia" come into "practice"? This is worthy of the consideration.

CHAPTER 3

TYPES OF MEGA AND DEFINITION OF GROUP FORM MEGASTRUCTURES

3.1 The Definition of megastructure

This thesis summarizes the history's definition then gives the definition of megastructure as follows:

Scale: Big enough to afford all or part of the city's function. In l996, Paolo Soleri was commissioned by seventy-five Japanese corporations to design a Hyper Building--a self-contained, three-dimensional city for 100,000 people --one kilometer square by one kilometer high[18] and it could be regard as one of the standard of megastructure. Vantone Company, the developer of Veritcal City also use a silimar standard: 100,000 people (a small city scale), covers an area of 1 square kilometers with the total construction area of 6 Million square meters and the volume rate of 6.

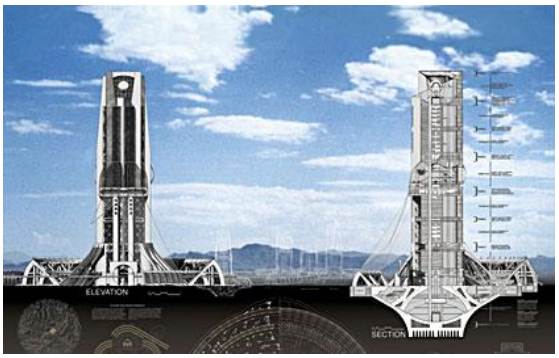


Figure3.1: Hyper Building, Paolo Soleri,1996.

Figure 3.2: Veritcal city, Vantone Company, 2011.

Function: As a vertical dimension level city, its function should reflect the Functional composite City with reference to the existing one hundred thousand city scale, its function should be embodied as follows:

Production Function: building, modern service industry, agriculture etc.

Public service Function: (reference the current China city scale that determines neighborhood offices and some residents committee).

School: a set of secondary schools, some of the primary school.

Hospital: a comprehensive hospital, community hospital service number.

[18] "Hyper Building", accessed by May 2th, 2014. https://sites.google.com/site/edenspaceproject/terms-definitions/hyper-building.

Municipal infrastructure management.

Residential Function: including apartments, hotel style apartments, SOHO and other functions.

Business Functions: big business, small community retail, catering and entertainment.

Leisure function: public greenbelt, square, street and different levels of public space.

Space: Non simple linear space, public space system with vertical under complex conditions, reproduced in the Vertical Square and street, courtyard lamp, tunnel.

Morphology: Morphological and histological construction can be divided into two categories: integral type and group. The integral construction is the traditional classic sense of the giant, permanent structure so huge that occupy the main status (can be understood as "trunk") and several alternative modular unit (can be understood as "leaves"), the entire building to bear part or all of mega structure function.

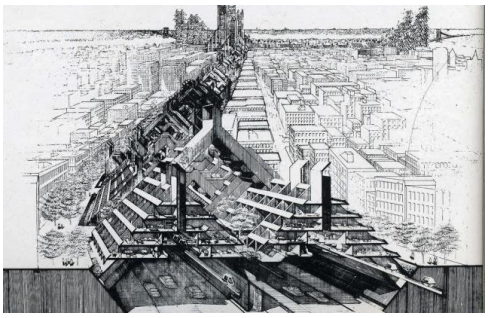
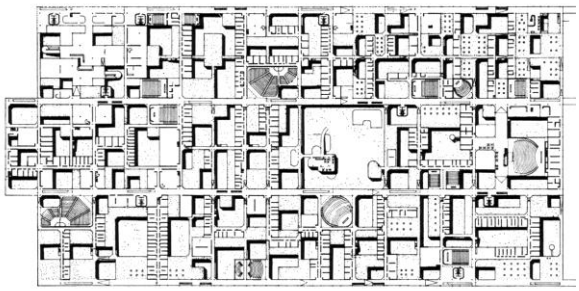


Figure 3.3: Shared Infrastructure: Fuji Television Headquarter, Kenzo Tange,1996

Figure 3.4: Continuant: Ford Foundation, Paul Rudolph,1967-1972.

Shared Structure: There should be a shared structure system in the Group-Form Megastructure, and it always exists in horizontal dimension.

Continuant: There should be a physical connection to make the group buildings into a whole system.



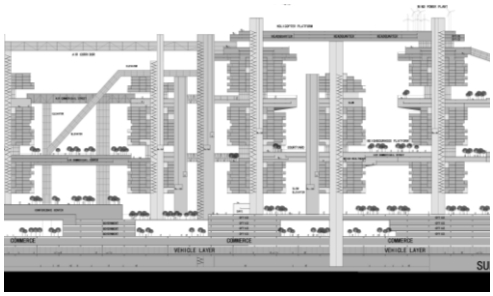


Figure 3.5: Organic: Free University, Berlin-Dahlem, Germany, 1963-1974.

Figure 3.6: Vertical Urban System. Source: Tongji Asia Vertical City Group,2012.

Organic: The whole megastructure is an organic system. Each part rely on each other and connect closely.

Vertical Urban system: The Group-Form megastructure should have a complex vertical urban system to afford the diverse urban life.

3.2 Types of megastructure

From this point of view on morphological relations, mega could be divided into two types---Integral-Form Mega and Group-Form Mega. Integral-Form Mega as the mega in the classical meaning is composed of a permanent structure occupied by the dominant position (which could be understood as "trunk") and several replaceable modulus units (which could be understood as "leaves"). The whole building is responsible for part or all of the megastructure function.

It should be noted that the Group-Form Mega is different from the group-form modeling which Fumihiko Maki discussed. Fumihiko divided architecture into three forms---combination-form, mega-form and group-form. Mega-form is a top-down organization from the main structure to units. The group-form modeling is an organization from bottom to top which the order is originated from the grouping process of several units. In the diagram for mega from Fumihiko, we can consider mega as a trunk with branches. The branches can be replaceable while the trunk is the main structure. At this design, Mega can be considered as the Integral-Form.

Figure 3.7: Diagrams of Compositional-Form, Mega-Form and Group-Form.

The Group-Form Mega in this paper is enlightened by Fumihiko, but the concept is quite different from his group-form modeling. It is not a concept coexisting with mega, but a form of megastructure. However, in Group-Form Mega, there is no dominant structure. Several relatively independent building groups blending with each other through space as a whole share urban function.

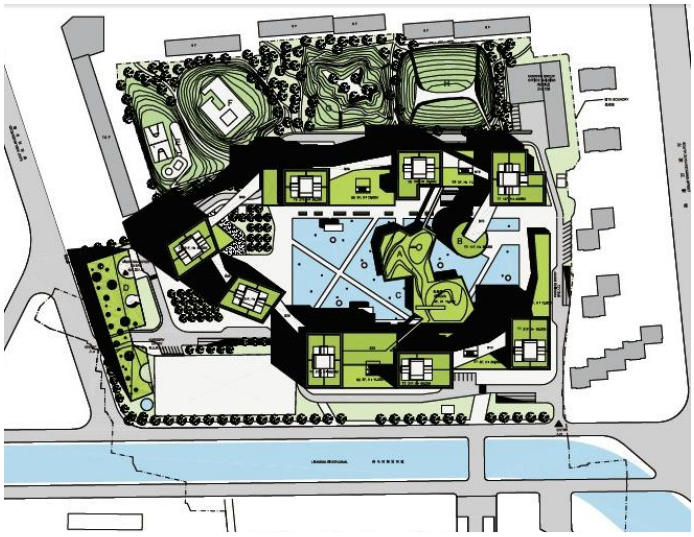


Figure3.8: Master Plan of Modern Moma.

In the late 20th and early 21st century, Integral-Form Mega is the main stream. It could be essentially considered as horizontal or vertical level. Integral-Form Mega in the vertical level, high-rise density, ”Super Architectre” by Koolhaas or “Crystal Island” in Moscow, could all be essentially considered to be further amplified or variant from skyscraper. Skyscrapers with a smaller area and higher levels take the whole or part of the city function most commonly. Integral-Form Mega in the horizontal level could be considered as a skyscraper lying down, which is low-rise and high density with bigger floor area, such as “Vanke Centre” by Steven Holl. But as the floor area is big, which is not conducive to node, so the vertical form is most common.

Integral-Form Mega has a relatively compact function, but either horizontal or vertical form would carry tens or hundreds thousand people as a whole huge structure, so Earthquake Safety

inevitably brings such a huge problem for the construction, so most of them just stay in the utopian conception stage.

However, the Group-Form Mega uses group-form buildings as its manifestation through horizontal contact of the ground or air, so the original architectural monomer concept would blur. Typical cases like Modern MOMA(Figure 3.8) by Holl can be seen as an eclectic form of mega and group form buildings. Similar to the high-rise group buildings, the appropriate technology has matured while the single building is conducive to lighting and ventilation for real practices.

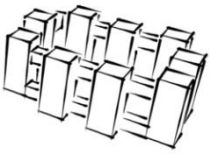
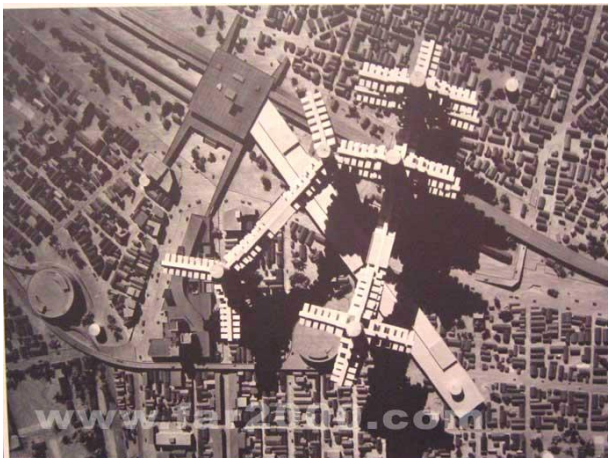
		Height	Land Area	Character	Diagram	Case
Integral -Form	Horizontal	Low	Max	Close to ground， Low FAR， High density		Vanke Center
	Vertical	Highest	Less	High FAR High density, Compact Function Simple liner space Difficult to build, against traditional culture		Crystal Island, Changsha Sky City
Group-Form		High	More	Its vertical space is more easy to be accepted by public, easy to built		Modern MOMA

Table 3.1: Comparison of different mega-forms. Source: done by Xu Yang.



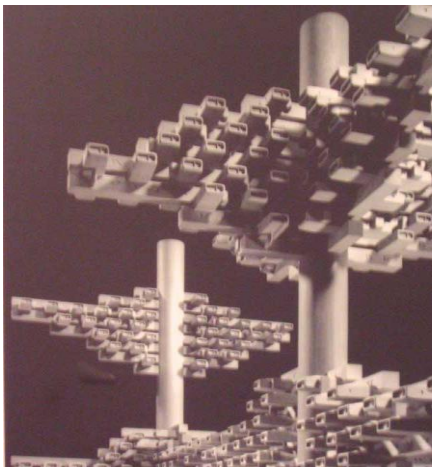


Figure 3.9, 3.10: City in the air. Arata Isozaki,1961.

In fact, in the revolution of megastructure, Group-Form Mega is always the option. Kenzo Tange has put forward the concept of “City in the air”. And it could be regard as one of the earliest Group-Form Megastructure.

3.3 Group-Form: Compromise between traditional mega and high-rise building

In the trend of mega-city, large buildings have appeared. However, due to its overall giant structure, seismic and other factors related to disaster prevention is difficult to achieve. In addition, the function of mega takes the whole or part of a city’s function and living could not be ignored. In China’s condition, strict requirements for sunlight and ventilation are needed, and policies are even stricter. These problems cannot solve the Integral-Form Mega because it is very expensive. Once the fund chain is fractured, projects could not be finished, such as Liujing Hotel in North Korea.

For example, the "Sky City" project in Changsha plans to build a 220-storey, 838-metre-high skyscraper mega in Wang Cheng District. Once it is completed, it could reflect a typical vertical Integral-Form Mega that could accommodate 30 thousand people. The whole area would take up to 1 million square meters (including 83% residences for 17400 persons; 5% hotel for 1000 persons; 3% hospital for 1400 persons; 3% office building for 2000 persons and 3% shop and canteen for 5000 persons[19]). PREFAB construction techniques would be used so the project plan would be completed in 90 days with an investing fund no less than 4 billion dollars.

Figure 3.10: “Sky City”, Changsha, on construction.

However, as the policy is complicated, the project is still under discussion with considerations for security and others. In fact, the biggest problem is not to be the claimed “highest building”. Actually the Guangzhou Tower has reached the height of 600 meters and Burj Khalifa Tower even reached 828-meters height. The real problem is that the function of the built super high building is relatively single, most of which is commercial offices including a hotel and office building. However, for the Integral-Form Mega,

[19]“Sky City”, accessed by April30th. http://baike.baidu.com/view/8751394.htm?fromId=1701316

it takes up a city's function where living is most important. For example, the "Air City", can fit 17,000 people to live in that equals to the size of a small town. There are many uncertain factors that would exist such as disaster prevention if we too many people were placed in the same building.

Today's Integral-Form Mega is like a stadium, television center and exhibition center that is led by the government. The large buildings with single functions provide some kind of symbolic meaning such as the Bird Nest and China Pavilion (Figure 3.11-12). As the function is single, it cannot take the city function, so they can be called huge structure rather than mega.

Figure 3.11: China Pavilion in Shanghai EXPO.

Figure 3.12: Beijing National Stadium.

Mega city subverts the sense of traditional city. In the last one hundred years, the city always developed in the horizontal way, such as walking, private car and public transportation. A variety of city life and urban cultural industries are built on the basis of horizontal public space of crowded square, busy commercial streets and secluded neighborhood. However, the existence of huge structure challenges the traditional public space. It means fast elevators and vertical transportation take place on original streets and public space that forms a new lattice.

When buildings shift from the horizontal to the vertical dimension, the respective spatial layout should be changed. Today's high-rise and high-density building, such as e city complex, it has a 2-dimension linear transportation so that the traffic jam would be unbearable in the peak period. They lack open spaces. Though many high-rise buildings have an atrium, fresh air cannot come in. People don't get close to the earth so they would not feel practical. Especially in the Integral-Form Mega, the vertical dimension would seriously weaken the relationship close-to-earth feeling. The reconsideration about mega could promote the nature characteristics of the human.

The Group-Form Mega would be more practical where single buildings would guarantee the sunlight and ventilation. When practice of group-form mega has been achieved and successful,

the people will become more interested. Then, this group-form mega is a compromise form of mega which is more practical.

It should be noted that, though the Group-Form mega means high density and intensity, it does not equal to a high-density group building. Fumihiko Maki commented that mega is a form of city, so that the main difference between mega-city and high-density building is the complexity of city's function.

In Hong Kong and New York, high-density buildings, especially high- density residence is very common, in which the main purpose is to provide more living area. Chinese traditional living area includes many levels of city public space, street and alley, courtyard, and living spaces, etc. Continuous space level from public to private is corresponding to the people's feeling and cognitive habits. The traditional space relationship is a presence of reticular. However, in the high-rise residential area, the level of inner space is not multiple most of which has vertical transportation spaces like stairs with horizontal relationship in the private living space. This space over focuses on the privacy of living while lacking corresponding public space.

Traditional high-rise buildings extend the vertical space by stacking where the space of each level is equal and enclosed. This type of space structure attempts to pursue maximization of the area for use under the design standard for economy, function and rationality. The vertical link is just for function but architecture should serve the people and get close to nature rather than applying an independent system. The courtyard space in traditional buildings and Greenland in both cities are effective ways to merge human with nature that share eco space created at the same time with city buildings. However, many people live away from the earth as well as nature.

The existence of Group-Form Mega can effectively solve this problem. In the concept of Group-Form Mega, the transformation from horizontal city to vertical city is an important step which the final form is bounded to be different from single space structure in a high-rise building from the past. It has several levels of a space system, function system and eco-system. Monomer blends closer and the relationship changes from the traditional bottom annex to different levels in the middle and top. High-rise group buildings combine the functions in different single buildings through public space while in the underground and annex level. The link underground is similar to the underground commercial that usually connects transportation such as Wanda Square in Wujiaochang.

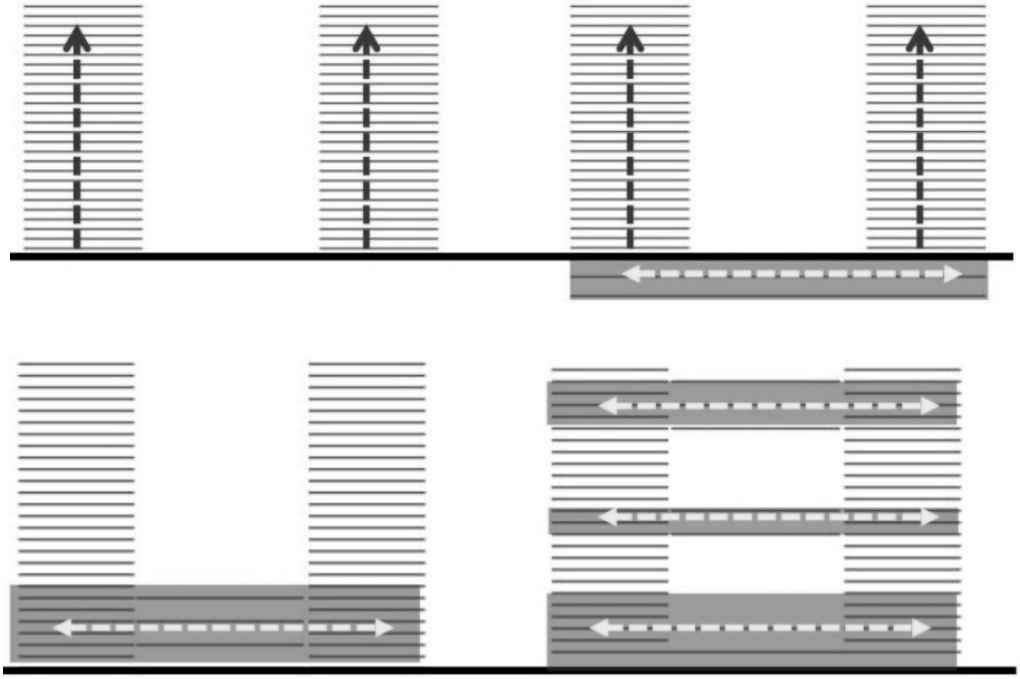


Figure 3.13: Comparison between group high rise buildings and Group-Form Megastructure.
The group high rise buildings lack the horizontal connections or the connections are underground or on ground. In the Group-Form Megastructure, the horizontal connections are very important parts and they could exist both on the bottom and in the sky.

However, Group-Form Mega is not the same. To realize the three-dimension of the space, horizontal connections are made in the air in the form called “sky corridor”. Transportation in the air is linked with ground and underground level to form annular vertical transportation system. Since the appearance of 3d space, boundaries between single buildings in the Group-Form Mega are no longer specific, so that the buildings blend with each other through public space.

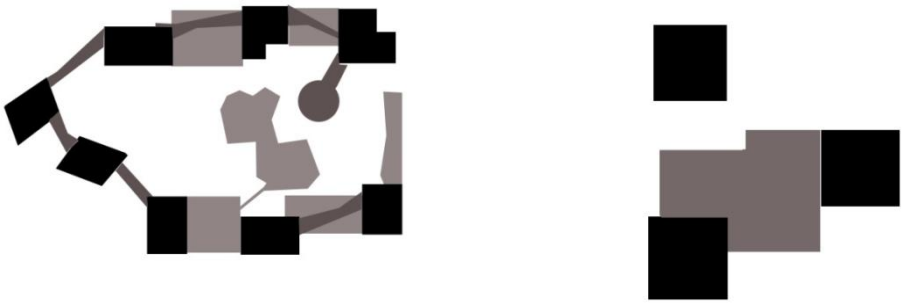


Figure 3.14: Master plan’s comparison between group high rise buildings and Megastructure.
Left is master plan of Modern Momoa, right is master plan of Taida Square.

It should be emphasized that horizontal links are not as simple as “sky corridor”. They are commonly combined with public service infrastructure to strengthen correlation in interior space of Group-form Mega. At the same time to ensure the density, horizontal links are improved to promote public communication. Characteristics of Group-form Mega could be generalized as follow:

Space urbanization: Characteristics of city public space are well reflected in Mega. We cannot easily misunderstand Mega as a connection between high-rise and residential buildings because the horizontal dimension City is usually concentric, no matter spiritual (like churches) or physical (large city public space like squares). The Vertical city should also have corresponding large public spaces as its city center such as the “Floating City” in Japan and the design imaginary in the 1960’s from Columbia University which sets up a square in the air.

Besides, city space in Mega should show the series of the public space. Public space in traditional high-rise residence (like green space between buildings), semi-public space (first floor hall), semi-private space (garden into the house and corridor) and private space (living space) could connect with each other in the “streets in the sky”. Streets play an important role in city’s daily life and represent the social public characteristics. In a sense, humans love to be close to the earth. When buildings are low-rise, they love to solve their living problems on the “earth” but while the city is vertical, people would weaken their relationship with the earth so we would want to create an “sky corridor” to accommodate people who live up in the air. It is an important standard to evaluate the utopia in vertical city design on how to create city streets and squares. On one hand, the general layout of the street and space can be made up but part with people’s life must obey the authenticity of life, to reappear the traditional 2d city life rather than an overstating boring "slum" on the vertical dimension.

Function complexity: As said before, the inner function space should have all or part of city function, including the following parts: 1) life function (traditional living function and corresponding service infrastructure in high-density residence, such as school, hospital and commercial and 2) productive function which is totally different from tradition. Mega emphasizes on one or several mature productive chain with high-speed development of modern information. We no longer need water and a large site so that top industry like IT, design, or financial businesses and other service industry for living would be possible.

City ecology: Mega, as a product from high-density population, the ecology should have two sides- First, it should be a benefit for eco energy from the point of intensification. The circulatory system to reclaim people’s living garbage could be considered. Second, the large

surface from the intensity can prevent eco disaster as a collection for sunlight and raindrops. Besides, disaster prevention should be reflected in the city ecology. Escape measures for earthquake, typhoon, and fire should be considered such as refuge floors.

3.4 Drive force and Social Significance of Group-Form Mega

3.4.1 Desire of Urbanization

Mega solves the population problem with less land, which the core is to improve the land use efficiency. Throughout the development history of Mega, the problem for mega arises from the consideration to improve the land use efficiency. In China today, scholars and builders pay much more attention on mega because of the land problem.

China is in the period of fast urbanization. In 2000, the urbanization rate in China is 36.2%, while the urban population is 460 million. By the year 2010, the number is 47.5% and 630 million; while in 2012, the rate was over 50%. It is estimated the new urban population would be rise to 350 million[20]. Even though, it is still far from the level of a developed country (85%), future development still has large space.

The city faces the land use pressure from the gathering population. Though the absolute value of land is large, 60% of that is mountains, plateaus, hills or deserts. Besides, 1.8 billion arable land red line (1,200,000 hectares) is set for national food security, which makes the usable land in the city is even less. The land area of China is similar to America, but arable land per capita is even less than 1/10 of America, which means the traditional pie-mode is not sustainable in China. Urbanization has brought large-scale transformation of the old and new town construction that leads to the city continuing to spread outwards. In the 1990s, the city built area expanded 938km2 per year, while in 2000 to 2007, it was even two times faster (1861km2 per year). So with the lack of land and urgency of urbanization, it is practical to provide a mega-city development mode both with high-density and high FAR.

[20] Lin, hejia, and na Li. "Vertical City——Practice of intensive and compact development in the China." *Design Community* (2012).

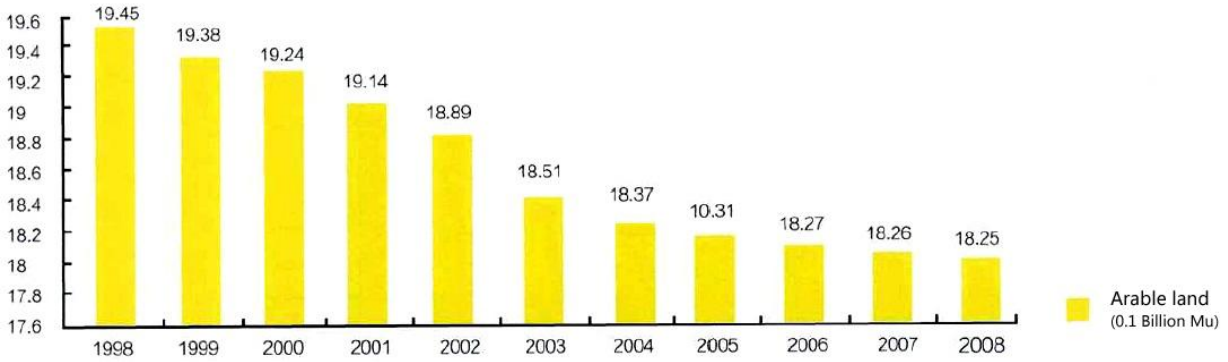


Table 3.2: Statistical changes of cultivated land area in China

Country	Cultivated Land Area	Per Cultivated Area	Percent of Average Area	Percent of Cultivated Area	Percent of Population
China	18.26	1.38	40%	7%	19%
USA	29.6	10.5	290%	13.15%	5%

Table3.3: Contrast between China and United States The area of cultivated land and per capita cultivated land

Today, China faces an unprecedented need for housing construction. Lack of effective land and rise of land prices is not enough to rely entirely on the needs of real estate market regulation process. he Chinese government suggests to build 36 million social apartments in five years. Under the current urban design condition, regular high-rise or super high-rise buildings cannot achieve a high FAR. Modern practical projects like Dashiling State Apartment at Singapore and other group-form like mega could reach the FAR up to 9.28. Research in mega in could provide us with new ways to extend the FAR restriction while ensuring the quality of life.

In recent years, the rising housing price is a big concern for public. The composition of the price and the land price accounts for a large aspect. The group-form mega could effectively reduce the land price through a high FAR to control the fast rising house prices.

3.4.2 Technology Economy and Policy

Construction technical obstacles in construction of mega have been overcome. Mega- city was considered to be a utopia imagination in the past. Besides the cost, the difficulty of construction cannot be ignored. Before the appearance of the mega-city concept, such as large span, ultra-high-level contacts, continuous construction and other technical aspects have been considered as insurmountable difficulties. However, with technological advances and technology accumulation in recent decades, mega city in the structure has no insurmountable difficulties. Examples like Beijing MOMA sky corridor, Crystal Island in Moscow are very

convincing evidence. The further development of industrialized housing cleared the difficulty of construction for mega city. Confined to a huge structure, the city is difficult to construct at one time, so it could be able to sustain growth under the conditions not to influence the residents. These techniques which traditional construction methods cannot guarantee could be met by industrialized residential manufacture.

The development of eco technology and spring up of eco-architecture cases, the Zero Carbon Museum of Shanghai World Expo, solar technology, water recycling technology and other ecological technology have been successful combined with architecture they provide a guarantee for the group-form mega ecological structure.

The development of mega must be accompanied by a large number of funds and large-scale land policy. With the development of the economy in China, large developers already have considerable strength. Developers advertise the 3d city while at the same time announce to put 50 billion dollars into the project.

Different from abroad, the land in China belongs to the nation. Under the current condition, large land uses could be guaranteed with the support of government and the residents would agree if their needs are met. Local governments usually provide benefits to advance their financial development with the consideration of GDP. XiXian New District in Xi'an, Chengdu, and Langfang in Hebei have agreed to put several square kilometers of land to develop a 3d city project.

3.4.3 Mega trends of Metropolis

Each rise of mega has a social collective consciousness. Arab, Asia and other emerging developing countries lack a deep confidence because of the history reason. In recent years and with the rapid development of economy, they have a enormous amount of funds to build mega so they would gain national respect through building skyscrapers and mega. This arises from a deeper social awareness and in China it is even more obvious. Large areas of empty space are developed to be new city. In these areas, the contour of mega forms the skyline with such as buildings as the CCTV and the Bird Nest. In the period of economic globalization and expansion of eyeball economic, the public and ministry show frantic enthusiasm for "Great things"[21]. Wealthier government and the public love to show the difference to the outside world through big events like the Olympics and EXPO. These events can further stimulate the development of the mega.

[21] Lin, Zhongjie. *Kenzo Tange and the Metabolist Movement: Urban Utopia of Modern Japan*(Beijing: China Architecture & Building Press, 2011),260.

What's more, with the problems like traffic jam, people have a deeper consideration for the problems of today's city. If we reconsider about the mega, we would find the similarity with traditional "People's commune" while the unique conditions of China has advanced for the revival of utopianism.

3.4.4 Promotion of Public Communication

When high-density settlements developed more maturely today as our society have escalated conflict mentality. As the people yearn for the ideal life of "sunshine, air, green land and low density", some of the high-density settlements squeeze the public space which become a gathering place for population which led to a series of social problems. High-density settlements actually becomes a "living machine" and loses more humanistic care. Though it is not totally fair for high-density settlement, we still have to reconsider today's condition.

Under these conditions of the FAR, the city has two developing modes- high-rise and low coverage, and low-rise and high coverage. High-rise and low-density buildings are just like an extreme form of vertical integral-form mega. They just have 2-dimension linear transportation, so traffic jam would be unbearable in the peak period. They lack open space. Though many high-rise buildings have atrium inside, fresh air cannot be let in. People couldn't get close to the earth, so they would not feel practical. Disaster escape is a big problem, especially such as "9.11" terrorist incidents and earthquake in Japan this year. There is another problem of vertical that is instability. However, it also has advantages such as intensity and high efficiency of the land use.

Low-rise and high-density buildings are just like an extreme form of horizontal integral-form mega. Like India's slums with the labyrinth-like transportation, people can go somewhere in a specific way and it is very crowded. They lack public and open space, in which streets are narrow and space is tiny. The efficiency of land use is very low. Under the restriction of 1.8 billion m of farm land. It's urgent and important to raise the land use efficiency because the health problem is very prominent and the recycle and treatment of garbage is slow.

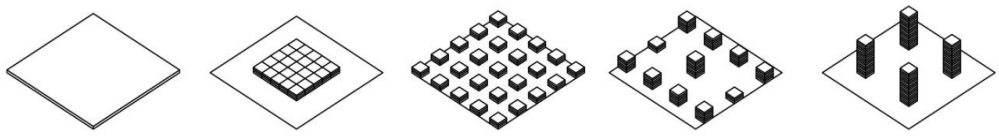


Figure 3.15:The analysi of density in the same FAR

High density is a necessary requirement of land-saving development. However, the current high-density developing mode has its social problems and living limits, so people are eager to have new urban forms. Group-Form Mega is between the two developing modes which keeps both the privacy and provide a public communication place among people living in.

In December, 2009, CTUBH chose Modern MOMA as the world's best high-rise building of the year. These group of buildings is only 66-meters high, which is not the highest building among candidates. The committee believed that we cannot create an energetic vertical city if we do not mix it with city function and the infrastructure. Modern MOMA is a practical form to realize.

Nowadays in the high-rise settlement, relationships among the people are more indifferent. The public space for people is usually the ground floor outside. With the floors get higher, people get less close to the earth and lack communication. The design of semi-public space like air gardens, such as “Air Courtyard” in Hangzhou by Wangshu, could promote public communication. Interaction between different levels of people could reduce the department of living in some sense. Besides, Group-Form Mega restricts the function in certain range, which could encourage the public communication. New Urbanism hopes to promote public communication by reducing the walking radium, which is similar to this issue.

3.4.5 Combination of Inhabitation and Work

Nowadays, the mode of horizontal urban sprawl has caused a lot of problems. First, it is a waste of limited land. The redevelopment of city center has become a gathering place for commercial offices, so the residents move to the new districts in the suburbs, which led to the department of industry and living. Large numbers of people spend more time on the way from work to home. The tidal-form traffic from the suburb to the city center every morning and evening has brought a lot of pressure to the traffic such as Shanghai, a typical example. This causes a big waste of resource and energy which exacerbate problems of environmental pollution and urban traffic congestion.

Architects and urban planners gradually realize that high-density settlement which just relies on transportation and vertical development could solve one aspect of the living population. Without the support of schools, hospitals and other public spaces, it is not sustainable and could lead to a “sleeping city”. In the future, “vertical” period, no matter how exaggerating the form is, the sustainability and humane care must be on the base of traditional city. Group-Form Mega is not just a settlement but takes up a city’s function, which integrates living, relaxing and working. The impact layout of “Inhabitation and Work in One City” could enable people to get to their

working place through walking and vertical transportation, which reduces the dependence on private cars and encourages the development of walking and bicycling.

3.5 Summary of Chapter

This chapter divides the mega into Integral-Form Mega and Group-Form Mega. Among them, the group-form mega makes the individual buildings indistinct by the connection of ground and high level. It could be regarded as a compromised form between the classic "Utopia" and the group high rise buildings. In the period of the urbanization which need a large amount of construction land and residential units, it have a positive social significance, which also is help to solve the problem of separation of inhabitation and work.

CHAPTER 4 CASE STUDIES

4. 1 Cases of buildings influenced by group-form megastructure

4.1.1 Introduction

A research and analysis was conducted on the case of Modern MOMA in Beijing, Pinnacle@Duxton in Singapore, Marina Bay Sands in Singapore, Citizen Center of Hangzhou and Galaxy SOHO in Beijing. These cases have s strong base Group-Form Mega and designers have tried the three-dimensional space and function complexity. However, in the case study, some of them do not meet the definition of Group-Form Mega. Some have low complexity of functions and some have a weak sense of three-dimensional space so they are called group-form building with large structure. However, with a lack of mega, it still has a strong reference which can provide guidance for the future Group-Form Mega.

4.1.2 Modern MOMA

4.1.2.1 Project Summary

Modern MOMA lies in an advantageous location north of Yingbing National Road in Dongzhimen. The area of this project is 220 thousand square meters. Some spaces include housing 135 thousand, commercial take up 85 thousand[22], as well as the art theatre, gallery and library, together with hotel, international kindergarten, top restaurant, top club and sport and the life infrastructure like gyms, swimming pool and tennis courts.

Steven Holl designed the Beijing Linked Hybrid where he developed a 3d space link from a 2d link of horizontal and vertical. In December, 2009, CTUBH chose Modern MOMA as the world's best high-rise building of the year. The group of buildings is only 66-meters high and may not be the highest building among the candidates. However, the committee believed that in order to create an energetic vertical city we must mix the city functions and the infrastructure. Holl expresses a strong trend of mega which in a limited space, it broke the barriers of the limited horizontal and vertical space to achieve the 3d space. The original building is split between monomers and encourages people to communicate in a high-density community that combines the living functions with other city functions. After the first meeting with the client, Holl said that, “I made a promise that only if they gave the project a real dimension of public to make

[22] Shijian, ” Linked Hybrid Steven Holl’s United Habitation Marseille”, *Time Architecture* 02(2009).

it open to the city would I design for them. It must further the vision and a new model in Beijing---"City in City"[23]. He wanted to set an example for the 21st century housing.

4.1.2. 2 Form and Spatial Layout

Steve Holl's design concept comes from the drawing, "Dancing" from Henri Matisse in which several people danced hand in hand. Here the buildings of different height are connected by sky corridors. The expressed poetic idea in modern residence was to remove the barriers between units, creating new means of communication.

As a group-mega-form building of city function complex, eight towers of 22 floors are linked connecting 750 apartments. One ne of the towers is a hotel that opens to the city with a large landscape lake in the center, a cinema and several green dune hills. Under the hills are the kindergarten schools, commercial and activity rooms for the elderly. In the bottom, the architect added several public functional spaces such as commercial, coffee and exhibition center. Holl wanted to create a harmonious atmosphere for the walking community. It has three different levels: the ground level, the roof garden and sky corridor. On the ground floor, people could reach the service infrastructure like dry cleaners, banks, supermarkets by walking. This level is opened to the city so that people could easily walk through it. The walking lanes connect the shops, restaurants, hotels, schools, kindergartens and other public facilities. There's also a cinema in the community center located in the center of the building. The roof of the cinema is in the center and connects other roofs, which forms an extensive roof garden. In the sky corridor level, a multi-functional "sky street" connects eight living towers and one hotel. In the loop "sky street", people could enjoy the beautiful scenery while at the same time have social activities in places like swimming pool, gym, coffee shops, art galleries. Architects designed the space 3-dimensional space through the link of three level attempting to promote relationships among the people. The distance is shortened so that people could meet each other and communicate with the neighbors making a harmonious healthy living environment. In addition, with the earth dig from the underground parking area, five unique hills with specific creational functions were laid in the open space---"Hill for Kid", "Hill for Youth", "Hill for Prime", "Hill for Elderly ", and" Hill Forever". Here, the scenic views were preserved while at the same time improving the green space.

In Group-Form Mega, the boundaries between single buildings are blurred, space is mixed and the space could be 3-dimensianal. In Modern MOMA, architect did not use the traditional mode of laying commercial annex along the street and placing the high rise in row. It breaks the

[23] Shijian, " Linked Hybrid Steven Holl's United Habitation Marseille", *Time Architecture* 02(2009).

condition that high-rise buildings connect with each other only through the ground floor, and connect variety of functions in a three-dimension network-like layout, which shows the physical feature of megastructure.

Figure 4.1：Perspective from the ground to see the Modern MOMA. The Modern MOMA locates in the No1 Xianghe Road, Dongcheng District. Architect: Steve Holl. FAR:2.64. Floors: 21 Floors[24].

Figure 4.2: Perspective from the Shy corridors to see the Modern MOMA.

4.1.2.3 Corridor in Sky and Verticalism of Space

The most special feature of this project is the sky corridor and also the key point which separates from other high-rise buildings. In the design of Marseille Apartment, Le Corbusier created seven inner streets, while in Modern MOMA of Holl, he deisgned the sky streets become energetic rather than just for transportation.

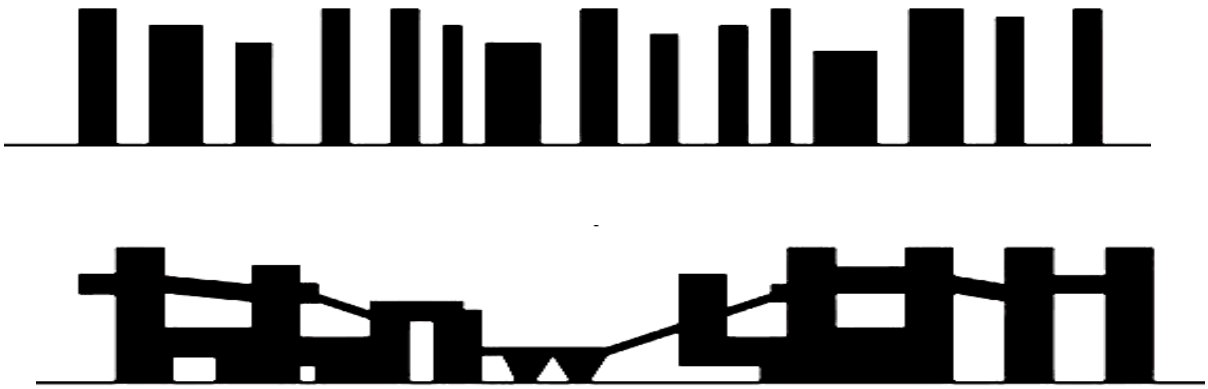


Figure 4.3: Modern MOMA Skyline

The sky corridors connect nine buildings, while breaks the communication barriers between people. There're swimming pools, gyms, art galleries, tea and coffee houses, and restaurants in the sky corridors. When you look down from the corridor, you can overlook the group of

[24] Shi, Jian. "Linked Hybrid:Steven Holl's L'Unite d'Habitation de Marseille." *Time +Architecture*(2009): 106.

buildings and the whole city, which has brought a rich spatial experience. As Holl said, “The pleasure of living in metropolis is to feel the space in pieces and overlook the whole city in air”. However, in the research, there are just two of the corridors opened to the public now and they are rented for company activities only.

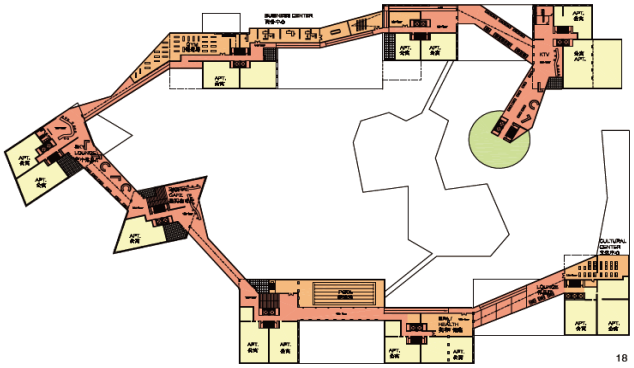


Figure 4.4: Master plan of sky corridors in Modern Moma.

Figure 4.5, 4.6: Perspective of corridor in the sky.

In Group-Form Mega, the three-dimensional space is closely connected with the complexity of functions. The tspace attempts to combine the functions where public communication is promoted. On the ground level, commercial streets, cinema, hotel and open-to-public hall are organized in the center of lake. Second, visitors could reach the sky street on the 18th floor by using elevators from the three hallways on the 1st floor. Here, the visitors could enjoy the service of tea, reading, fitness and beautiful scenic views.

To guarantee the safety and convenience of living residents and improve the pleasure of walking, the privacy could not be influenced by the flow and logistics of other function at the same time to strengthen their communication. The underground parking entrance located near the site barely influences the inner transportation yet provides a comfortable walking space for the inner people. This is an important joint design linking the community with the city. In Modern MOMA, the people arrive at their houses by the in-home elevator. Management facilities were set up in the lobby and access control systems to ensure their privacy and safety.

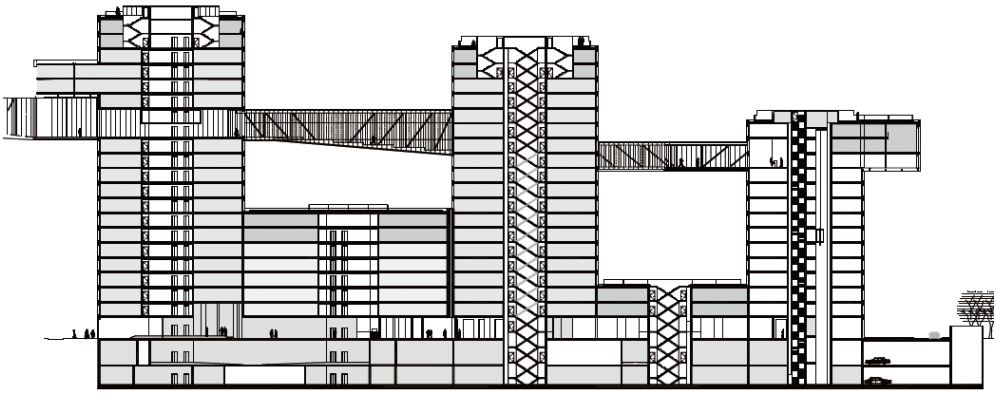


Figure 4.7: Section of Modern MOMA.

4.1.2.4 Ecology Trends

In Group-Form Mega, the eco-system plays an important role. Renewable energy was used largely in Modern MOMA. There are 660 geothermal wells in this project and each could provide 10kw energy to lower the temperature which keeps the room temperature between 20 and 26 centigrade. Adjustable external shading system, replaceable air system and under floor air distribution system is all expensive energy-saving measures in MOMA. Windows at the east, south and west end uses special stainless steel roller blind, so that in the summer it could effectively block the sunshine radiation and not influence the inner sunlight.

The eco-system is closely linked with the three-dimensional space. The public roof garden is also part of the eco-system. Raindrop collection system is added in the roof gardens of annex and hills. 2,000 cubic meters of raindrop collection pool is set in the north hill for recycle use.

4.1.2.5 Analysis and Summary

In the “neighborhood” was the concept expressed in Holl’s design. He thought the traditional neighborhood relationship could be posed by the streets and courtyards. Today, there are more “residential settlements” existing in Beijing and many other cities which is the product of the “tree-like structure” idea. The practice proves that many disadvantages are exposed in this mode, so he attempted to make a change in his design. He reorganized the functions and made them open to the city and strengthened the network among the functional blocks including the horizontal and vertical levels.

However, Modern MOMA is set as a top residence. Sadly, as a protection for the high-income, the developers set a wall outside the community creating the open mega-city into a

gated community and lost the dynamic character. It should be pointed out that, the gated system did not forbid strangers inside (I myself had visited this building several times) but with the guard's presence, people were uncomfortable to get inside. The inner public facilities serves the living residents rather than the citizens, so the industries, were not well developed. During the design period, MOMA wanted to achieve the goal of "living and working in the same city", so in the 200 thousand square meters of whole area, office spaces occupied 40% of the building. In consideration of creating the house into SOHO, the elevation of the house is similar to an office, which does not conform to traditional residential impression. In this design, many people would like to live in compared to the traditional residence nearby.

The sky corridor is the most special place in this project and visitors often visit there. However, for safety reasons, only two are open to public access while the others prohibited walking through all the buildings in the loop corridors. This section is used as a show center for selling and clubs.

As a megastructure in practice, Modern MOMA has a positive exploration in the three-dimensional space, functional complexity and vertical ecology. In today's condition, it is not totally open to the city, and the megastructure turns into a residence. People living there do not have adequate communication. The design of the house does not conform to the traditional living habit, so only certain types of residents would select these units. The gated community also makes the industry inside not well developed. These are all problems we should consider about in the mega design.

4.1.3 Other Group-Form Mega

4.1.3.1 Pinnacle@Duxton

Singapore is a typical country with very little land area and a large number of people. Limited land resource and an increasing number of population make Singapore explore a developing mode of higher density. "Before the Pinnacle@Duxton, the maximum FAR was 4.0 with 40 floors.[25]" Located in Duxton, Singapore, this project was developed by the Singapore Housing development Board and was a good attempt for super high density development. It covered a land area of 2.51 hectares, with a total building area of 233,657 square meters and has 51 floors and 1848 sets of apartments[26]. The FAR is 9.28 that exceeded the definition in Asian Vertical City Competition of 6 and even much more than the FAR of 2.6 in Modern MOMA. Similar to the Modern MOMA, architects also introduced the "sky street" as a concept to guarantee the living standard for residents in high density. The sky corridor on the 26th and 50th floor connects 7 tall buildings together but it is not same as those in Modern MOMA for the practical functions. The two floors of fold linear sky garden provide residents with more open space and a great view to overlook the whole city. Residents could rest and enjoy the view of the city. Qiu Binming and Huang Wanjing , the designers, thought that, "Besides the unique design, the public space is combined with the high rise to energize the community." [27] In the 2012 World Architecture Prize, when committee explained why Duxton has won the award, they said that this project moves the public space up the 20th floor that showed a new idea of high density city.

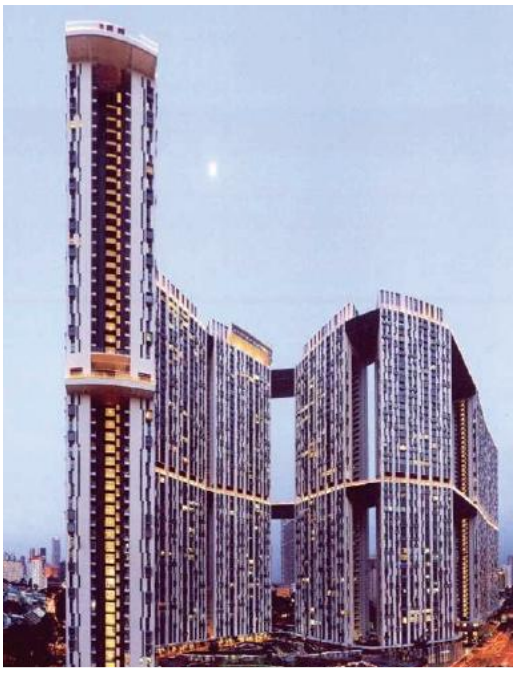


Figure 4.8: Perspective of Pinnacle@Duxton.

[25] Li, Qing, and Chiong Lip. "High Density and Liveability: Duxton Plain Public Housing."*Time+ Architecture*(2011): 71.
[26] Li, Qing, and Chiong Lip. "High Density and Liveability: Duxton Plain Public Housing."*Time+ Architecture*(2011): 71.
[27] Accessed by May 8th, http://www.chla.com.cn/html/c74/2010-11/67968.html.

Lefe: Figure 4.9: Perspective of the roof garden.

Right: Figure 4.10: Bird perspective of roof garden of Podium in Pinnacle @ Duxton.

The sky garden is not only the need for transportation and disaster prevention but also a public activity space for residents. There are outdoor seating, children's playing facilities, walking lanes and other public activities. Besides, the podium is set as a Residents' Committee and shops while the roofs served as public gardens. In the entrance to the city, the roof platform is integrated with the city where coffee shops, net bars, markets, clubs, sports centers, dinner place and children's parks are located. This becomes a very dynamic public space (including the ground floor) to release the pressure from the high density. Residents could reach the public space with the 20 floors that alleviates the psychological sense of oppression from the high density.

It should be noted that the prefabricated modulus production is used in this project. Easy modules could achieve a rich overall texture. The elevation is made up of many combination. The single unit uses the precast concrete slab system in an area that is 93-97 square meters and 105-108 square meters the unique ranging to the family condition.

Compared with the Modern MOMA, Duxton is more close to megastructure in density with a FAR of 9. The sky corridor activates the higher space while the roofs form a dynamic public space. Prefabricated industrial production is also a useful exploration for the Group-Form Mega. However as the single industry, other public infrastructures are only based on the living function.

4.1.3.2 Marina Bay Sands

Marina Bay Sands is a large complex in Singapore sponsored by the Las Vegas Sands Corp. It is located in the south bay of Singapore and occupies 2.06 hectares of land. The building area is 929 thousand square meters with an FAR 4.5, 50floors and a height of 200 meters[28].

[28] Luxury and Magnificent-Marina Bay Sands" *Architecture&Culture*(2011):24.

The amenities include high rated hotels, outdoor swimming pools, air gardens, international meeting and exhibition center, theatres, a museum and shopping center. The total construction cost was 11 billion dollars that was designed by Moshe Safdie and Associates. The architect designed a support system of the floating platform in the air that is divided from the crowded urban environment and creating a good quality environment in the air. Arata Isozaki and other architects had thought about how to create a good public space in the air. With the development of the economy and technology, Safdie had realized his dream. and he had hoped that Marina Bay was not just a building but also a micro world in Singapore combining culture, climate and modern life. “Our challenge is to create an energetic public space with street scale and to express the human scale in the mega-scale city.” [29]

As a complex of several functions, Marina Bay has 2560 guest rooms, exhibition center, shops, restaurants, theatre and casino. The sky garden is on the 57th floor and is 200 meters from ground. It connects three towers and takes up an area of more than 10 thousand square meters. This area provides a public viewing platform, jogging lanes and 150-meter-long swimming pool overlooking the whole city from the air. The developers said, “It is an unspeakable good feeling, like boarding top of the world.”

The architect’s design strategies of the air garden and mega-city of the Marina Bay was very successful. In my research, it provided a very dynamic roof garden. However, we should also pay attention that to the high rated hotel. The people who are served are the occupants of the hotel and their family. It is a place for few people to enjoy the privacy of the club because it is not open to the public.

Left: Figure 4.11: Roof garden of Marina Bay Sands, perspective from the swimming pool to see the downtown of Singapore. Right: Figure 4.12: Perspective of Marina Bay Sands.

[29] Safdie Architect

4.1.3.3 Citizen Center of Hangzhou

Citizen Center of Hangzhou, which locates in Qianjiang New City in Hangzhou, is a new landmark. By interview of the architect, Professor Li Linxue, the total building area is 580 thousand square meters and composed of 6 main buildings totaling 200 thousand square meters. What is more important are spaces of the new libraries, the Teenagers' Center, the office center are all included in the Citizen Center that is not single function.

The Citizen Center of Hangzhou also has a good exploration of the three-dimensional space. The high-rise buildings are connected by the sky corridor. Through the conversations with the designer, the sky corridor is served as public function as restaurants connect the functions of the high rise. The center roof of the conference center is designed as a garden and the podium as a library, canteen. The other infrastructure does not lose the energy of city. In the random investigation of the citizens, the Citizen Center is a great landmark for them to get involve in. From the complexity of the functions, it lacks the functional living spaces. So, it could not be called the Group-Form Mega but it is worth learning about sharing space with the surrounding environment.

Left: Figure4.13: Model of Citizen Center of Hangzhou .

Right: Figure 4.14: Perspective of Citizen Center of Hangzhou.

4.1.3.4 Galaxy SOHO

Figure 4.15: Master plan of Galaxy Soho， Zaha Hadid，2011.

Galaxy SOHO , designed by Zaha Hadid, is located inside the East Second Circle in the city center and its developer is SOHO China. In the physical form, it could be seen as a Group-Form Mega that takes up an area of more than 50,000 square meters and the building area of 330,000 square meters[30]. It is a large complex made up of commercial and office space with an FAR more than 6. The Office space occupies 166,000 m2 and the commercial space 86,000 m2. This elegant group of buildings not only create a flowing and organic inner space but also an attractive landmark in this area. The strategy is to create five buildings in the big block that integrate with each other as a whole. The form of the buildings corresponds to the surroundings and the moving sun patterns. The people could enter from different directions and the buildings has adequate natural sunlight.

Galaxy SOHO provides a new idea for the Group-Form Mega. In Modern MOMA and the Pinnacle @ Duxton, the three-Dimension space is realized through the sky corridor in the horizontal dimension. However, in Galaxy SOHO, the horizontal factors integrate with the building itself. Single buildings combine naturally without obstructing the sky corridor.

In Group-Form Mega, how the architects could ensure the natural light if we do not use sky corridor to connect the single buildings? On one hand, as a commercial complex, the restriction for natural sunlight is not as restricted as the residences, but on the other hand, large atriums are designed in the center and around the lifts and elevators. Each atrium has a dome skylight window to provide natural light and indoor positioning. The atriums and inner streets are linked together, meanwhile, the atrium dome directly links with the “valley” that is open to the sky, around the offices. People can enjoy the natural light and overlook the city at the same time. The outside corridors are connected as a circle. The people could have a diverse view

[30] Da Qiaoyu and Wang Suijiong,”Following the Flow Galaxy Soho by Zaha Hadid Architect”, Time Architecture, 05(2012).

experience , with one side showing the large-scale metropolitan and the other side the small-scale traditional streets.

The architect also attempted to design the buildings more eco-friendly that include the following such encourage the workers to use energy-saving transportation like bicycles. Also, the design provided dressing rooms in low-energy cars while using the cold roof system to reduce the “Heat Island Effect”. Finally, the building also uses water-saving landscape features as well as recycling water throughout the facilities.

The three-dimension space in Galaxy SOHO was not very successful because the platform is not dynamic and all the positive space located inside the building. However, this design has provided a new idea for the innovation of Group-Form Mega. Similar to CCTV building by Koolhas, the form could be understood as a consideration for making the vertical space horizontal, but the horizontal connection is blended with the building itself as part of the exterior.

4.1.4 Summary

The cases could be regarded as the exploration of the Group-form megastructure. The research was positive on the diversity of space (from horizontal to vertical), diversity of function and vertical ecology. From table 4.1, Modern MOMA could be regarded as a successful case but after construction it degenerates to a gated community. Pinnacle@Duxton's function is simple because it is generally all residential units and it is similar with mega in the perspective of FAR. Marina Bay Sands, Citizen Center of Hangzhou lack the functions for the inhabitation because it cannot satisfy the function of mega. They also explored how to make the public space in the air and how to deal with the relationship between mega and city. Galaxy SOHO's vertical public space cannot be seen as "successful" but it provides new ideas on form.

	Architect	Area	FAR	Height	Verticalism	Functional Diversity	Vertical Ecology	Others
Modern MOMA	Steven Holl	230000	2.64	21 Floors	Corridors in air	Highly	Ecological Technology and Vertical Greening	Gated Community.
Dashiling State Apartment	ARCSTUDIO	234000	9.28	51 Floors	Corridors in air	Mostly Residence	Park in air	Lack function of Work
Marina Bay Sands	Safdie Moshe	930000	4.5	50 Floors	Square in air	Highly diversity, lack residential function	Roof Greening	
Citzen Center of Hangzhou	Li Linxue	200000	2.1	26 Floors	Corridors in air	Highly diversity, lack residential function	Garden on the roof of Annex	Annex open to the city
Yinhe SOHO	Zaha Hadid	330000	6.0	18 Floors	Connection in air	Commerce and office	New Technology	New solutions on the form

Table 4.1: Comparison of different cases influenced by Group-Form Megastructure. Source: done by Xu Yang.

4.2 Cases of Horizontal Cities

As a form of a high-rise city, we cannot neglect the city property itself. We need more cases which combine the strategy of architectural design in high density conditions and horizontal urban organizations.

4.2.1 Reston

Reston is a census-designated place (CDP) in Fairfax County, Virginia, United States. It is located 35 km west in the city of Washington, 15-minute way by car from the Washington Dulles International Airport. It covers an area of about 45 square kilometers, covering 7400 acres, planning households 28000 households, and the population is 60000 residents. The designer thought it should be “a place in which to live, work and play”[31]. The aim was to design a sustainable community and town with its own hematopoietic function. This function could provide the community residents and families in different stages of development to housing and community services.

[31] Gause, Jo Allen. *Great planned communities*(Washington, DC: ULI-the Urban Land Institute, 2002), 182.

Reston's design concept was "A place in which to Live, Work, and Play" that provided multi-apartment layout. The selection attempts to meet the needs of different age groups and income of the residents by providing a variety of property types. They included apartments to apartments to the detached villa meeting the diverse needs of home buyers for the property. The different area and product compound did not affect the uniformity of the community owners. The price standard was reasonable and was customers could meet the uniformity of the community residents. High strength met the needs of residential facilities supporting diverse use of space. Community public facilities included schools, libraries, police, cultural and recreational facilities, public transport and open space. Reston also introduced a large number of corporate headquarters, commercial organizations and government departments. Today, the town has reached the balance of living and employment. There are 60000 more residents with more than 40000 residents in the local work. At the same time, Reston's design led to the importance of the developing a good natural environment, moderate scale streets, small space and a well maintained green combination.

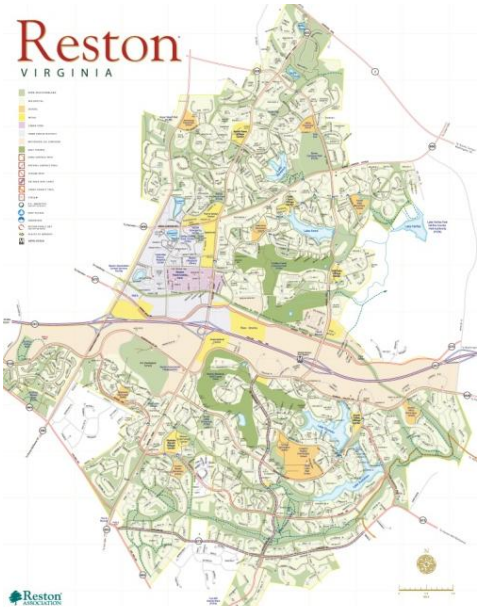
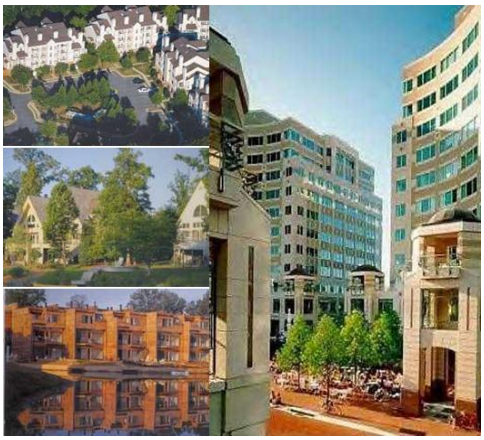
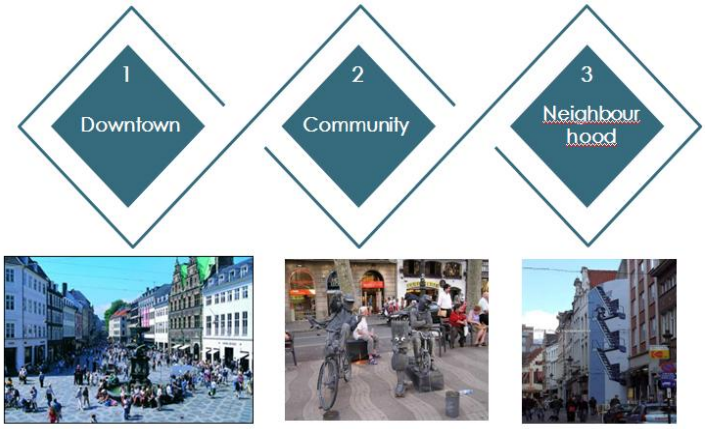


Figure4.16: Masterplan of Reston.

It is worth mentioning that, Reston is organized as ideal "neighborhood units" with three levels: the Town Center, Community Center, and the Neighborhood Center. Three level centers established the system of the perfect life by reducing traffic time of residents, enhancing community cohesion, and formatting the humanization of space. The Town Center and office functions are arranged conveniently to connect with the outside while the center is accessible to the community. The Town Center consists of a hospital, government services, library, commercial area, office area, housekeeping service center, health care facilities, and customs Commercial Street. In addition, it includes a high-quality daily retail, entertainment and other business functions, cultural activities and entertainment facilities such a community club and a public communication center.

On the hand, the Community Center offers variety different levels for the community open space, through the use of existing natural resources and community resources recycling. This could form a good living environment and create a platform for the communication and exchange activities that embodies the respect to the exchange and the fusion of middle-class community culture. Community commercial, community plaza, outdoor swimming pool, sports venues are spaces within the Community Center. The Neighborhood Center consists of the parking facilities, a small green space and has medium density with a variety of products form composite, paying attention to the living environment (multiple Lake).





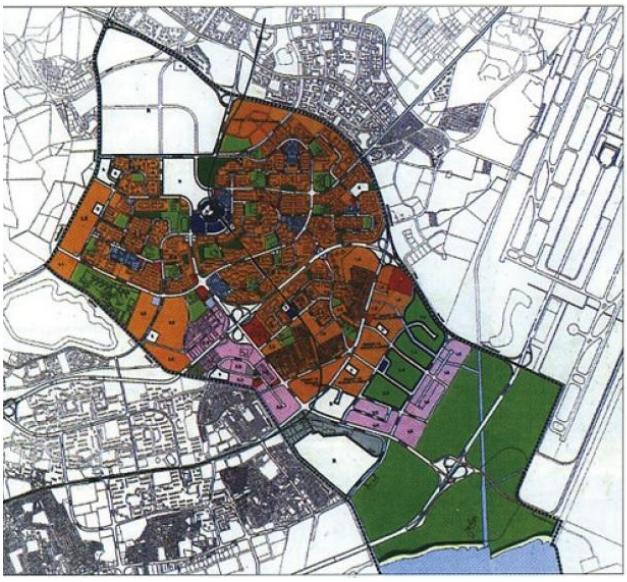
Left: Figure4.17: Perspective of Reston. Right: Figure4.18: Public structure of Reston.

4.2.2 Tampines

Tampines is the biggest residential community is located in Singapore in the east of the main island of Singapore. The area is about 21 square km with a population about 220000. There are 10000 residents per square KM. The planning dwelling units are 83000[32]. The structure of the new town is very clear and the layout of facilities is reasonable. The transportation is convenient and institutes such as Temasek Polytechnic could provide many jobs that help balance work and residences. The downtown of Tampines is one of three deputy centers of Singapore serving one million residents. The total area of commercial facility is 1.5 million square meters. Because of the development of TOD, the business atmosphere is already very successful. The structure of roads is clear where the main roads and secondary roads do

[32] [32] Wang, Maolin. " New Town Planning in Singapore and Its Revelation." CITY PLANNING REVIEW(2009):45.

not cross the residential communities creating a safe and quiet environment. There is one town level commercial center, 6-8 community level centers, serving radices is 400-500m, one town stadium, one town park, 10-15 community parks, serving radices is 300m. The serving radius of school is 400m.



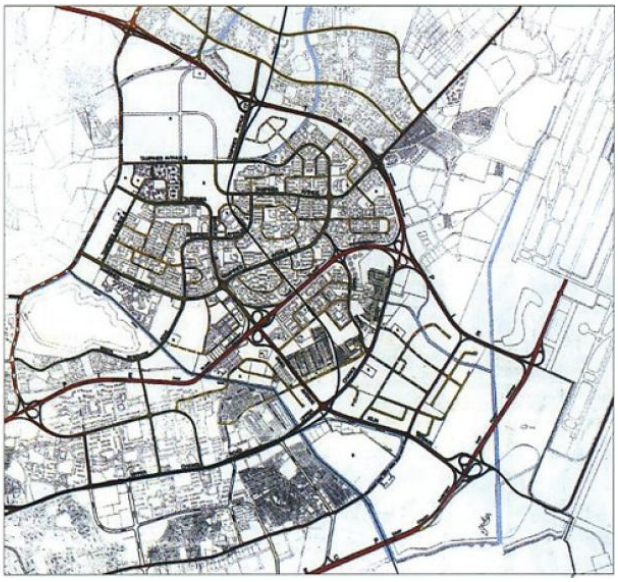


Figure 4.19: Land use plan of Tampines new town. Figure 4.20: Transportation plan of Tampines new town.

The residential types include a 2% low-density, 9% medium-density, 89% high density with a total of 84500 units[33]. The state apartments include medium to low-incomes families. The types of unit change from one bedroom to five bedrooms. The floors are always 6 floors, 9 floors and 11 floors. The FAR is 2.8, which uses the mode of high-volume ratio and the underlying form of residential overhead.

Its characteristics can be summarized as:

1.TOD development model development model

2.Planning concept if “Neighborhood Units”.

3.Lower overhead space, providing a broader communicative space .

4. for future commercial redevelopment space left.

5.A link way Walking System

[33] Wang, Maolin. " New Town Planning in Singapore and Its Revelation." CITY PLANNING REVIEW(2009):45.

4.2.3 Tin Shui Wei

Tin Shui Wei is the new town of Hong Kong and located northwest of the New Territories. It is a famous high-density new town with more than 280000 residents in only 4.3 square km. The density is nearly 67000 people per square km[34]. Kings Wood Ginza near Tin Shui Wei Park is the largest commercial center in the new town and is also the most prosperous part of the town. Due to poor planning, the commercial center is not near the traffic hub at Tin Shui Wei station. Planning to design the railway station at the downtown of Tin Shui Wei becomes a failure because it is located far from the commercial centers. Like the other successful new towns downtown mall, this station does not have enough flow of people. The price of goods in the mall is more expensive than other shopping district and many people only go shopping without buying anything. The local residents are mainly low-income families so it is difficult to attract large chain stationed boutiques and restaurants.

The other commercial centers are near the public housing. There are many houses, hospitals and malls in the area but not enough public facilities in the area such as libraries and industries. Due to the lack of industries, families are not able to support themselves and yet, the Tin Shui Wei is still from the downtown area that the people have to choose public transportation. Many people have to choose work and study in or near Tin Shui Wei due to the lack of jobs. High-density environment also lack the living quality. All of these ingredients, create a low-income residential community.

Recently TV, plays and films have told many stories about the Tin Shui Wei. It became a “City of Sadness”. In 2008, the government wanted to get rid of the "City of Sadness" image, setting it aside next to the Wetland Park, an area of 6.44 hectares to Tin Shui Wai. It is more like a bedroom suburb. The development of the middle-class elderly housing project named "Joyous life" provided about 1,000 units. The next project to build hotels, rehabilitation centers, child care centers and other community facilities that is expected to be completed in 2016 but due to unforeseen circumstances, it has to give up the plan.

[34] Accessed by May 8th, http://baike.baidu.com/view/134407.htm?fr=aladdin.

Figure 4.21: Bird Perspective of Tin Shui Wei. Figure 4.22: Bird Perspective of Tin Shui Wei.

4.3 Summary

This chapter talks about reference case study groups of the Group-form megastructure from two possible configurations. First, the thesis analyzes a series of high-density cases influenced by group-form megastructure including contemporary MOMA (although they cannot be called a true megastructure from the perspective of scale), but it still provide the ideas in the design solutions of Group-form megastructure:

1. How to use the podium in three-dimensional structure
2. The mega should open to the city and have public facility to share.
3. Vertical streets and secondary ground.

One type of urban form that cannot ignored is the urban property. Thinking through the above, there are three different cases:

1. A sustainable city cannot exist as a bedroom suburb, and it need industry to support, reaching the balance of residents and industry.

2. In the three level structure of town-community-neighborhood, each level's role is different. The downtown could afford the industry, promoting consumers and satisfying public service. The community satisfies the daily life of the residents and the neighborhood become place for daily communication of people. It should be mentioned, neighborhood is not the basic units of urban planning such as Reston with several individual houses make up a close group by nature. With the growing of density, such as the high density residential community like Tin Shui Wei, the neighborhood becomes the basic unit: a building can be a neighborhood and several buildings make a community and the public space of community become the smallest scale public space which residents can feel. The lack of human scale leads to the lack of life's quality.

3.Combined with transport hub. The urban center is connected with roads and the railway system promoting the development of the city.

CHAPTER 5 CONSIDERATION ABOUT THE URBAN SYSTEM BASED ON GROUP-FORM MEGA

5.1 Analysis of People's Need and Response of Mega-City Under the vertical dimension

A good living environment should have the quality to match different levels of space with residents' needs in the residential area. Living under the vertical dimension could influence the residents' psychological needs which would further influence their behavior.

People's Basic Needs	Living environment requirement
Physiological needs	Life, Comfort
Requirement for Safety	Safety, Privacy
Requirement for love and belonging	Social communication, sense of belonging
Requirement for respect	Field of sense, to be identified, to eliminate residential segregation
Requirement for self-realization	Participation, autonomy

Table 5.1: Table of people's basic need and the related living environment requirement. Source: done by Xu Yang.

Physiological needs- the most basic needs: Survival needs the community to meet their composite function of daily life. However, under conditions in high density, especially in today's simple high-density city, people's behavior could easily be restricted or lose control and excessive stimulation. Living conditions in high density would produce a strong sense of crowding. The desire for air and sunshine is also part of physiological needs.

Requirement for Safety- "Central Fear", while public space could be easily seen in high density: Living density would create a public space between people are more compact. While safety and privacy are threatened, negative emotions would appear.

Requirement for love and belonging- Requirement for social communication: People wanting to seek for a psychological sense of belonging and emotional satisfaction in communication, which include positive interaction to participate in chess and chatting, and "negative" or "waiting" interaction such as walking and walking their dogs. This is an important reflection of social energy. In the traditional city, courtyards and squares provide different levels of activity space for residents. While in high-density living conditions, people live high above the ground so people are separated from the street life. People's needs for social communication could not be satisfied because of the difficulty to form the sense of belonging to the community. For children and the elderly, it's more obvious. Living in high-rise buildings makes children rarely play outdoors making it bad for their health and difficult to watch-out for their safety. The elderly would also limit contact with their neighbors. Relatively, the close inner space in a high-rise building could easily produce loneliness and mental pressure for residents.

Requirement for respect- Sense of field, characteristics to be identified and elimination of living departing: The single function of high-rise living and mechanical "cage" living determines that the building is a pure "living machine".

Value of self-realization to participation in social management under control: Due to the large scale under a high-density community make it difficult for people to take part in. Based on the analysis above, the problems which should be urgently responded to can be summarized in the following:

1. Response to horizontal isolation in "Functionalism" urban planning: Under the influence of Le Corbusier and the "Athens Charter", modern urban planners and architects continue to divide the city into different functions in the horizontal dimension. Geospatial space meets the functional specialization and keeps people away. People communicate less and less, therefore, the city lacks human energy. In the Group-Form Mega, the city is rearranged from horizontal to vertical, which would effectively break the horizontal isolation. Under such "horizontal isolation", the separation of living and industry makes the urban transport "tide" a phenomenon creating the urban disease.

2. Response to lack of "close to ground" natural characteristics: People are naturally close to the ground with an abundance of air and sunshine. The ground is an important activity space for people to communicate with each other. While living in high density and high off the ground, people are less apt to exercise therefore, the sense of belonging to the society could not be formed. Separation from the ground leads to the lack of safety. Residents in high levels could

not clearly watch street activities. The layout of the high-rise community does not have the sense of a closed space that leads to the lack of public defense.

3. In addition, people have an innate sense of intimacy from the sun. To ensure that every household could have the equal right to enjoy the sunshine, the form of a big pie cannot be guaranteed. The Group-form mega could satisfy the form where everyone is a single tower and connected to each other. This would ensure every house could receive sunshine and satisfy the integrity of every household resident would live in dignity rather than a great suffering oppression slum.

4. Response to unbalanced space scale and single level: In the old city, the space level which people commonly keep in touch is rich and orderly. In today's high-rise new city, people could feel the public space of the "city" level and "community" level. The public space on a smaller scale is more suitable but is lacking the people's daily interaction. However, while family decreases in size, the emphasis is focused on more independence and privacy. Considering the protection on privacy, people communicate less in an unbalanced public space. The diversity of public space is also easier for residents to establish identification of the living environment.

5. Response to mass media and information technology: People rely on Internet and social media increasing the need for virtual communication. From another aspect, today's city mode could not satisfy the space need for people's public communication, so they voice their demands through interacting in a virtual space. With the development of the information technology, office buildings are becoming very popular. Combing the Mega City and industry under high-rise conditions is possible. What's more important is the rise of information technology creating the city management to become level so the neighborhood in Mega City is important.

6. Response to special transportation: In a traditional city mode, the transportation under the neighborhood is walking which is more substituted for elevators under high density conditions. The enclosed space environment in an elevator and high-speed stop-by-stop features lessen the contact between residents. It should be considered to be innovated so more people will rely more on the elevators in Mega City.

7. Response to city construction and management: Mega City is large in scale that construction process is lengthy. The step to build the Mega City should be considered combining the social management and physical form allowing participating from the people.

5.2 Establishment of Multi-level Public Space Sequence

In this thesis, the scale of mega is defined by creating living spaces for 10000 people. However, under today's condition, 10000-residents city is divided into City (district-street in China), Community (which could be understood as community committee) and Neighborhood or Precinct (which could be considered as a group of residents). In a New Town, a development in Singapore, the mode is called as New Town (150-300 thousand people, serving 1.3-1.5km), Neighborhood (4-6 thousand families, 15-20 thousand people, serving 400 meters), Precinct (400-800 families, 1.5-3 thousand people). In China, it is called the Residential Area---Residential Community (2-3 thousand families); Residential Group (300-800 families). Whether domestic or abroad, the division is similar.

In the American New Town urban design, the space organization is public, semi-public, semi-private and private. Based on this division, the level of Residential Group (Neighborhood), the basic unit of living environment is a courtyard (as the picture below). The Courtyard is used to organize a group of buildings and people defined as semi-private. For the upper level, it is semi-public space of Residential Community and public space of Residential Area. For the lower level, it is the private space of a house. The public space as courtyard is a touchable field for families that is considered to be identified as a safety area. Communication and belonging, people living are in agreement that the "family" and "close neighborhood" is vital. In this mode, semi-private space, semi-public space, and public space are at different levels of space for public activity. The multi-level public system made up of a field, small public building and Greenland could not only protect the privacy of residents, but also promote the development of communication. This is benefit help define the sense of community belonging. Under the high-rise conditions, traditional organization of the neighborhood is simplified. Several or a single high-rise (or super high-rise) could be considered as a group of houses. In the urban planning of Tin Shui Wei, we saw that despite the public space of a town and community, the neighborhood level lacked interaction. The first-floor hall played the role of the neighborhood public space while transportation space like staircase and elevator played the role of semi-private space. The lack of a smaller scale public space that could meet the people's need is unbalanced. Since family size is decreasing that the emphasis of the people is focused on independency and privacy. Based on this analogy, people could choose to communicate more or less in an unbalanced scale of public space.

As a result, in planning of Group-Form Mega, we would redefine the Neighborhood by splitting the original building in a vertical upward level into smaller units, and connect the lateral

level as a new neighborhood. Learning from the original concept of the courtyard, the concept of “close neighborhood” is introduced. The interior space to the public space such as the air courtyard and sky corridor is set to constitute the multi-level spatial sequence together.

5.3 Re-construction of Urban System

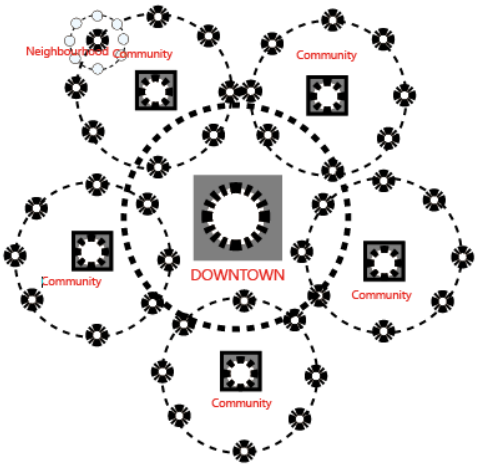
5.3.1 Hierarchical Relationship of Horizontal Cites Changes Into Cross Superimposed Relationship of Mega

The manifestation of the horizontal city is self-similarity. Different levels have corresponding centers to undertake public functions. In fact, not only in the new town planning but also in the traditional city development that unconsciously follows the corresponding development. In the City Centre, there is a square that houses a library, sports center, park, large commercial, and public service facilities covering the school. In the Community center, there is a level base commercial, retail, catering spaces and a community park. In the Neighborhood level center, it provides an exchange in the neighborhood public space that includes: open seats, pavilion, playground and other elements of the community open space. This system is based on the "control" of an organizational system. The main performance is in the lower level that is under control at the advanced level including an organization, administrative management, public buildings and roads with green arrangement. Different levels enjoy different areas at the town level, community level, neighborhood level is decreasing. Every level of the hierarchy is showing a centripetal relationship. The importance of the town center cannot be ignored in community and neighborhood because it often focuses on the "community" than the "neighborhood". Even the neighborhood space subdivision (lack of high-rise residential, high-rise building is a neighborhood scale (lack for the further design).

When the city completely comes into mega-form, along with the dimension from horizontal into vertical dimension, the relationship between the public and private system changes. Megastructure would be divided into three layers in a square kilometer of land: large schools, hospitals, stadiums and large commercial space are located on the ground and connected with the rail traffic playing an important downtown role in the horizontal dimension. The whole city is made up of the podium; platform and the towers are built on the platform. It is divided into several blocks in the vertical dimension connecting the horizontal system through the air. It is composed of the neighborhood public spaces and shared facilities. A certain number of units is connected to form a system of tower blocks in a community. The whole community is composed in a number of different height neighborhoods. Due to the

concentration of the density, the distance between people arriving at the City Center is shortened. The original community public service function is impaired and the community and neighborhood no longer appears as a centripetal radiation. Part of the public service function in the community is replaced in the bottom of the city public space while other part is scattered into the air neighborhood.

It could be summarized that hierarchical relationship of horizontal cites changes into a cross superimposed relationship which megastructure influences each other. The relationship is developed from the inside to the outside changing into the multi- point to the osmotic relationship which changes from down to up in vertical cities.



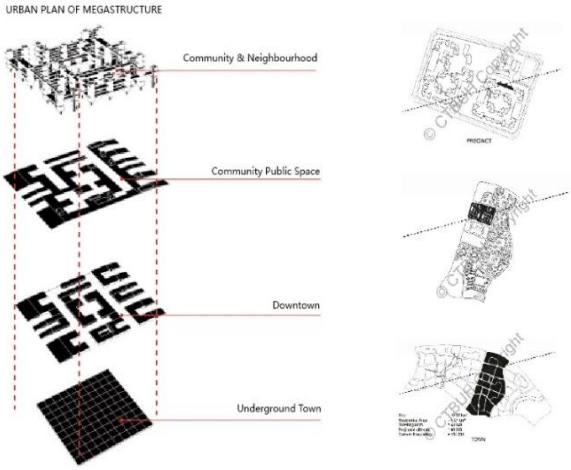


Figure5.1: Diagram of horizontal urban city: The urban space system is downtown-community-neighborhood, and the relationship is hierarchical and self-similar.

Figure5.2:Diagram of Group-Form Megastructure: The urban space system is downtown-community-neighborhood, the community's role is not as important as horizontal city and the relationship is crosswise.

5.3.2 Functions of Different Level for Public Space

Various levels of public spaces operate differently. In fact, the downtown of megastructure provides large scale public services and industry support that include: government offices, headquarters zone, large commercial space, a stadium and financial facilities. The original community center functions is weakened because of high density, including community level open space and community club, post offices and other infrastructure. The neighborhood takes the place of community in the megastructure including: neighborhood committees' offices, small

business, kindergarten, elderly care centers and neighborhood recreation sites. In addition, the neighborhood can also include a part of office space, providing work for community residents.

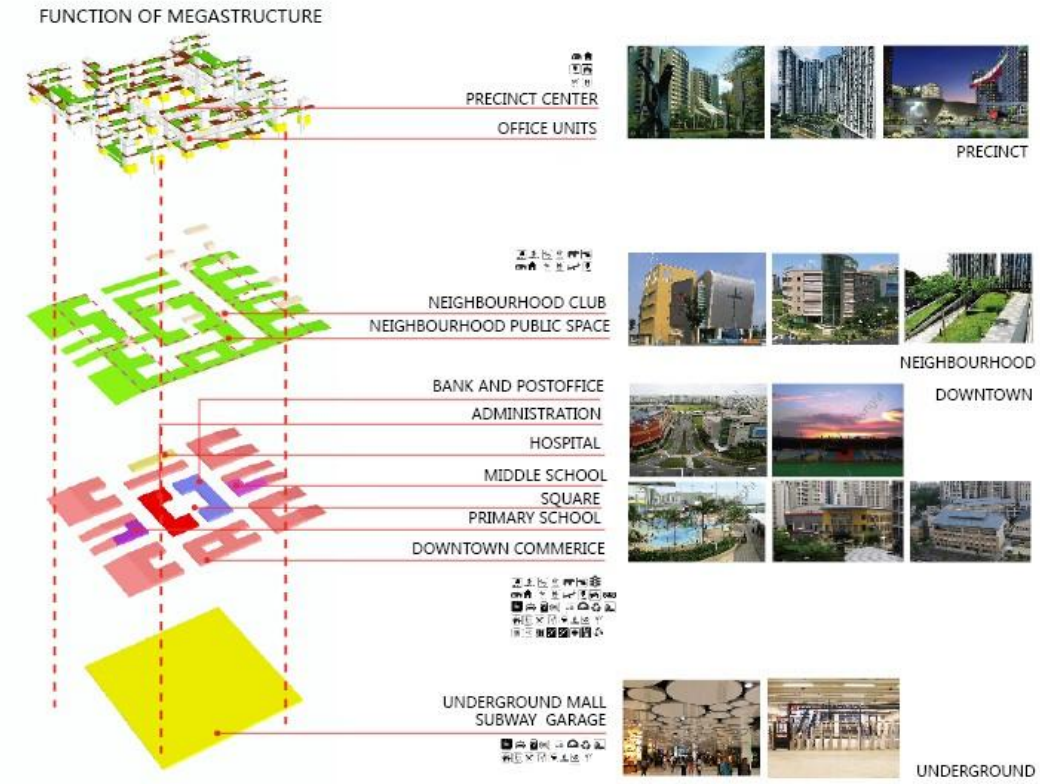


Figure5.3: Function of Group-Form Megastructure: Different level's public space's functions are different. The downtown of megastructure provides big-scale public service and industry support, including: government area, headquarters area, large commercial, stadium, financial facilities. The original community center functions become weaker because of high density, including community level open space and community club, post offices and other infrastructure. The neighborhood replaces community in the megastructure, including: neighborhood committees' offices , small business, kindergarten, elderly care centers, neighborhood recreation sites.

		Mega(town)		Community		Neighborhood	
Unit : square meter		Building Area	Floor Area	Building Area	Floor Area	Building Area	Floor Area
		1600-3000	2000-5000	1200-2500	1200-3600	360-850	500-1070
	Education	600-1200	1000-2400	600-1200	1000-2400	160-400	300-500
	Hospital	60-80（160-280）	100-190（260-360）			6-20	12-40
	Culture	100-200	200-600	20-30	40-60	18-24	40-60
	Business	700-910	600-940	450-570	100-600	150-370	100-400
	Bank, Post office	20-30 60-80	25-50	16-22	22-34		
	Public Infrastructure	70-430	100-880	40-420	50-480	9-10	20-30
	Admin	85-150	70-200	40-80	30-100	20-30	30-40
	Other						

Table 5.2 Function and area distribution of town, community and neighborhood in megastructure. Source: done by Xu Yang.

Name	Num-ber	Detail	Mega (Town)	Community	Neighborhood	Description	Scale	
							Building Area	Floor Area
Education	1	Nursery(< 3 years)			Necessary			4classes >1200 6classes >1400 8classes >1600
	2	Primary school	Necessary					
	3	Middle school	Necessary					
Hospital	4	Health Station			Optional	With the community club	30	
	5	Dispensary	Necessary	Optional			2000-3000	3000-5000
	6	Hospital	Optional				12000-18000	15000-25000
Culture and Sport	7	Culture club		Necessary	Optional		150-300	150-300
	8	Sports center	Necessary	Optional				10000-15000
Business and service	9	Supermarket	Necessary				4000-5500	
	10	Convenience Store			Necessary		50-60	
	11	Bookstore	Necessary				500	
	12	Hotel	Necessary				1500-2000	
	13	Restaurant			Necessary		500-600	
Bank and Post office	14	Bank	Optional				500-1000	800-1500
	15	Saving Branch		Necessary			800-1000	400-500
	16	Post office		Necessary			100-150	
Infrastructure	17		Necessary	Necessary	Necessary		30-50 200-30050	
Admin	18	Sub-district	Necessary				700-1200	300-500
	19	Police	Necessary				700-1000	600
	20	Neighbor-hood Committee			Necessary		50	

Tables5.3 : Detailed list of function of town, community and neighborhood in megastructure. Source: done by Xu Yang.

5.3.3 Transformation of Traffic System

In the traditional horizontal urban model, new towns often connect with the outside environment through the railway t (such as Tampines). Because of the long distances, people rely on automobiles from downtown to the neighborhood. In the megastructure, the railway system play an important role. The megastructure connects the outside cities by subway transit and set the underground garage and underground commercial space. After the residents arrive at the megastructure, the traffic model of the megastructure is turned into elevators and the pedestrian system in horizontal dimensions.

However, as a vertical traffic model in the high-rise buildings, elevators not only affect people's travel but also their communication. The mechanical model of transportation people stops on every floor and in the running process, the residents cannot pause whenever and wherever possible therefore, reducing communication. Though the elevator places people together, it is not a suitable communication space because it is a closed environment. The space between each person and their personal space is minimum thus, resulting in a sense of crowding. When the building is very high, the model of stopping on every floor is a waste of resource and time. Therefore, architects need to reform the traditional elevator model.

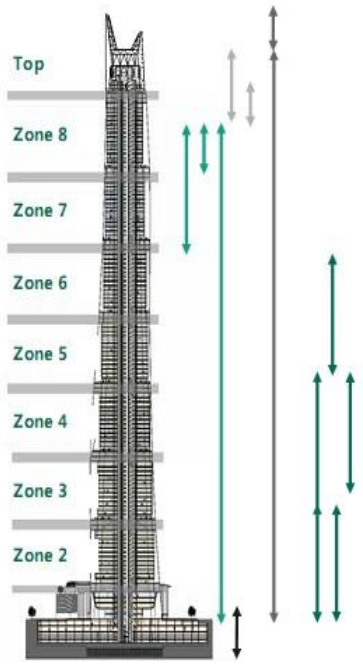


Figure 5.4: Transportation system of Shanghai Center. There are two different kinds of elevators in the Shanghai center, one is normal elevators which stop floor by floor, another is expressway, which stop by the public layers. People would take the expressway first to the public layer, then take the normal elevator to the destination.

Change from model of stop by stop to combinations of point to point and stop by stop. There are elevators that travel directly to the public layers. The public layers become public traffic hubs in the vertical dimension. In the author's investigation and analysis of the case, the MOMA and Pinnacle@Duxton . Residence also uses the point-to-point model, increasing the public property of public layers. The Shanghai Center on construction also use the model. It uses vertical zoning in the traffic Model. The people could arrive in transform-layers by point-to-point elevators from the ground then continue to each floor reducing the

concentrated pressure (see Figure 5.4, Figure 5.5).

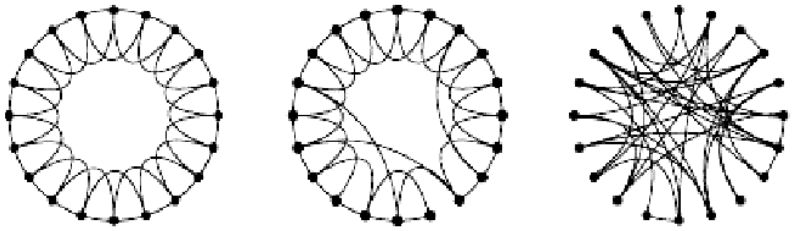


Figure 5.5: Diagram of small world. Some expressways could be introduced to make points be easily reached.

Combination with rapid traffic and slow traffic: In the horizontal urban model:

Walking is not the only a traffic model but is a way of social communications because of slow motion characteristics. Characteristics of the original elevator travel quickly making the social attribute stripping. It is recommended that the elevators could be combined with restaurants and rest stops that slow speeds used in the point-to-point elevators. People could then interact with social communications in the vertical traffic. The vertical restaurant could also become a special industry to attract tourists to the mega structure.

5.3.4 Relevant Changes of Community's Organization

In the failed case of the Pruittigoem, it demonstrated the need for strong public services in high density conditions that lead to lack of public services and social forces up rise. The Chinese community governance system focused on the vertical system from top down while the American community system emphasized the participation of social forces whose governance system is flat. In China, organization mode of the community has experienced the evolutional process of management scale, from small to large. In the regulations related to community management, neighborhood committee is a neighborhood of autonomous units that it should be in the service of the neighborhood level (100 -700 families). From top to bottom the governing system mode is: City –Street or Sub district----- neighborhood ----- residents group. Due to the increase in the city scale, there is a continuously extension and population expansion where the neighborhood committees often are set at community levels (10000-15000 people). It becomes an extension of that government. The special governing mode is reqired by the characteristics of megastructure. High density increases the difficulties of management.. Thus, in traditional cities, some of the functions of community center have to be replaced by urban facilities. It is suggested that neighborhood committee should return to the original neighborhood services

unit(100-700 units), forming a management system of megastructure (specialized management committee) - neighborhood committee, which is more flat. This system also emphasizes the combination between top-down(centralization) and bottom-up(self-governance).

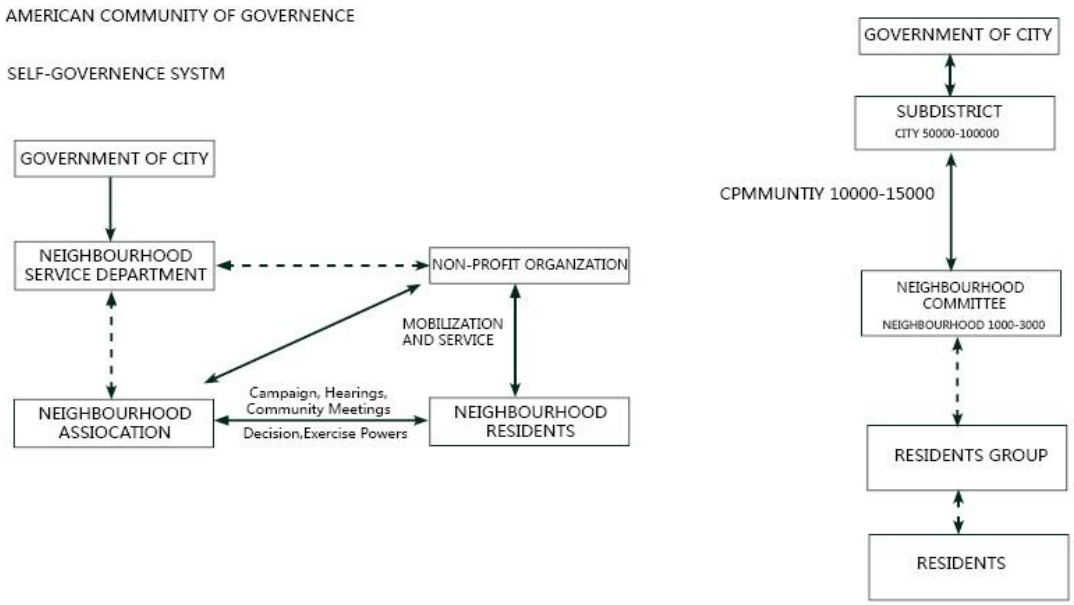


Figure 5.6: Comparison of American community organization and Chinese community organization.

Reston new town is another model that the municipal administration is managed by a half--profit agency called Reston. It is composed of 130 neighborhood committees and community volunteers association completing autonomy and management of the entire community.

Therefore, the characteristics of megastructure decide the special governance mode: High density, Multi-function, Long-term. High density increases the difficulty of management and easy to attract a large-scale slum by management vacancies. Multiple vertical space conditions cause administrative efficiency. In addition, due to the density of a highly concentrated area, most of the functions of community center are replaced by downtown. It is suggested the neighborhood committee should return the original neighborhood services unit, forming megastructure (specialized management committee, the street level) - neighborhood committee management system which is flat. It emphasizes the top-down and bottom-up.

In planning and the construction of Mega structures, it needs a long-term process and large sums of money.

In mainland of China, the government always established a parallel management organization such as an investment company who are in charge of the commercial operation. The mode of property management should change as well. In the existing mode, the residents committees choose the property management companies separately, and these companies in different communities are often irrelevant. But, in megastructure, different communities and neighborhoods are always connected each other and also influenced by each other. It is more like a highly integrated technology product, once the problem occurs in a part ofthe system, it is difficult to bear for the entire renovation and maintenance by the independent company.Therefore, it needs for a systematic property management of the whole megastructure. The mode has to be changed from the parallel management in the past into more crosswise management system.

5.4 Abstract of traditional city: From grid to matrix

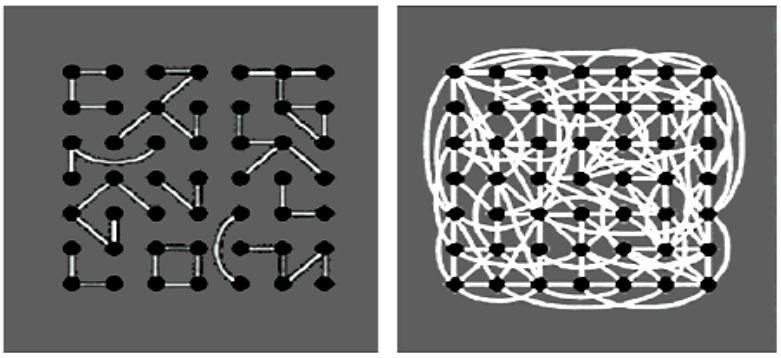


Figure 5.7: Abstract of traditional city: from grid to matrix. The group high rise buildings are more like grid, people have to come back the ground and then communicate with others. In Group-Form Megastructure, people could have more communications and the system is more like a matrix than a grid.

In traditional horizontal cities, lower houses and the houses under the business model are enjoyed by the residents. The existence of the High density city simplifies the spatial pattern where people have returned to the ground where they contact each other. In the transformation from traditional cities to vertical cities, architects hope to reproduce the rich street life and city space in the air, achieve the transformation from grid to matrix (Figure 5.7). This is an analysis diagram of a horizontal city where the space composition is very rich, squared with the main road and the path are defined. The group-form megastructure is the vertical superposition and reproduction of horizontal cites. The right figure is the vertical zoning map of Shanghai Center (Figure 5.11). In the articles, the tall building is vertically divided into 3 or 4 function regions, the composed units of megastructure changes from individual buildings to a functional zone and each functional area is set up to the corresponding public layer. These ideas of vertical partitions are often seen in today's skyscraper designs in the present design.

Based on the vertical functional zone, the megastructure emphasizes the development of horizontal system at the same height, public layer is connected through the horizontal dimension, intimate neighborhood unit several adjacent rely on air level connection to provide public space to form a new neighborhood unit.

With regards to Modern MOMA and Pinnacle@Duxton that may not be a true megastructure. Their aerial level system is delicate with a corridor and walking function. As mentioned earlier, megastructures focus on sharing infrastructure. The horizontal system in the air is an extremely important part of sharing the Infrastructure. In Metabolism movement, “Fuji Headquarters” designed by Tange Kenzō and "Incubator City” designed by Arata Isozaki brought forth the model of the horizontal system in megastructure. CCTV Headquarters designed by Koolhas divided two skyscrapers separating the ground and high altitude where the two buildings was regarded as the reality for the exploration and practice.

Figure 5.8: Fuji TV Headquarters Building. Location: Tokyo,Japan. Year Completed: 1997. Architect: Kenzo Tange.
Figure 5.9: Perspective of CCTV, Koolhas, 2009.

In the Group-form megastructure, relatively independent, the monomer is divided into several mutually independent sections; single mutual blend provides horizontal dimension with upper links. The mega-form city is divided into three parts: 1) the ground is a great space for activity, such as school, hospital, square, large commercial space activities, the giant stadium, towers and other great space; 2) the Vertical system take on functions of housing and transportation; 3) the original living street city functions system is put into public layer segments and is regarded as an important place for the neighborhood activity such as neighborhood level kindergartens, nurseries, elderly care centers, and small catering business. Here people are closely related to the activity room that even the roof serves as the secondary activity place for walking, recreational opportunities, making people at high altitude in the city functions closely connected with living still.

Here, the different attributes of the vertical dimension and horizontal dimension have been researched. The vertical dimension provides residents with private properties, playing the function of living, and the horizontal dimension reflecting functions of public properties in the city. Therefore, to strengthen its public property, the vertical transport within the tower between public layers is connected by vertical transportation space that can be directly connected to the city to strengthen the relationship between the neighborhood and the city. The existing high-rise development is high above from traditional street life and group-form megastructure want to reappear in the street life of the vertical dimension so that people can enjoy the rich city life

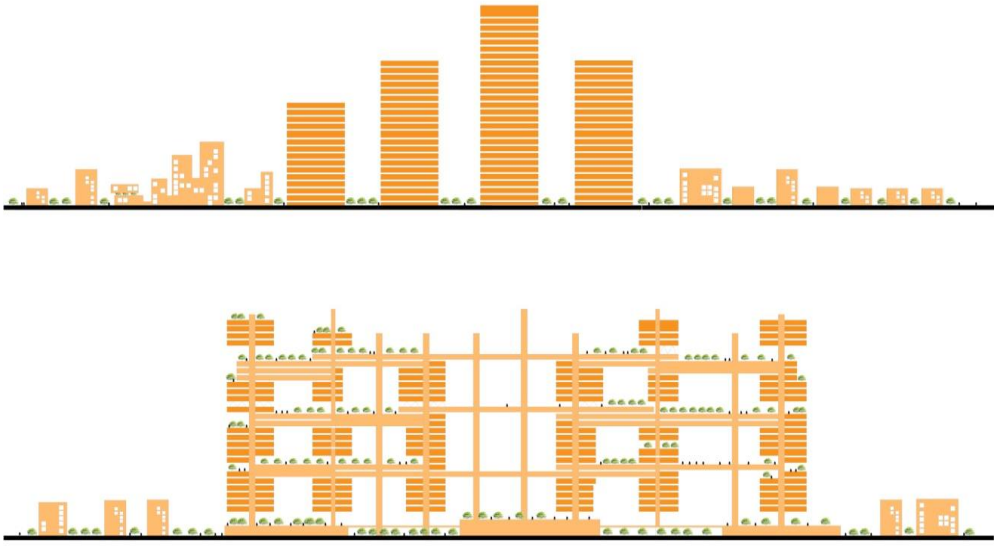


Figure 5.10: Change from group high rise buildings into Group-Form Megastructure. The existing high-rise development is far away from traditional street life and the horizontal connection could play the role of secondary ground to provide the diverse urban life for inhabitants.

Chapter 6 Guidelines: Design and Construction of Megastructure

6.1 Introduction

Based on the fifth chapter, the architect would explore the guideline of design and construction in group-form mega, and display them in diagrams. Noting that, in the design of mega, at the same time which provides rich city life for the residents in the building system of the level of vertical dimension, the following aspects should be paid attention to:

1. Location: As we know, large cities, Beijing such as Beijing and Shanghai are face to a high-speed expansion. In process of urban sprawl, urban development has brought large numbers of bed cities, resulting in separation of inhabitation and work, traffic congestion and a series of other problems. While, Group-Form Megastructure is precisely the key to solve this problem.

Group-Form Megastructure is not located in the desolate countryside, it should be at the suburb of a metropolis, became to satellite town to reduce the pressure. High land prices cause investors to high-density development model, complex urban transit system and the road system provide possibilities of transportation for megastructure, complex internal space and complete industry provide residents diversity possibilities and make huge conurbation constitute a real big city, rather than simply bedroom suburb[35].

2. Identity: Megastructure cannot follow the same pattern, different communities and between groups should show different characteristics and properties, allowing residents to build sense of identity and belonging of community.

3. Possibility of change: It may include several levels of meaning. In the city level, it should not be solid, and it can change along with the change of residents' number. It could be added, removed, even demolished after a long time use. For each family, they have the rights of movement freedom; the residential units can also be changed with the change of families' structure.

4. Maintenance and management of the community and residential units include social organization, property management and other requirements.

[35] Bedroom suburb: it suggests that residents sleep in these neighborhoods, but normally work elsewhere; they also suggest that these communities have little commercial or industrial activity beyond a small amount of retail, oriented toward serving the residents.

5. Combination of mega city and ecological technology, establishing a sustainable eco city.

The following chapters will discuss three aspects: 1) bottom interface of city, 2) neighborhood system in the air and 3) city's construction.

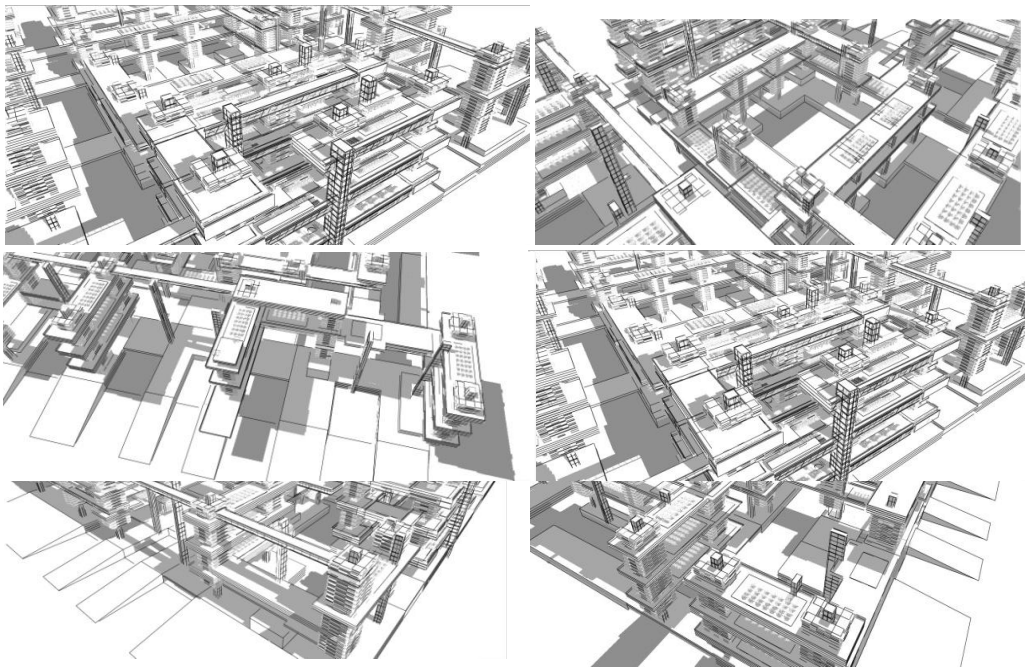


Figure 6.1-6.6: Perspectives of different parts in the Grouo-Form Megastructure. Different communities and between groups should show different characteristics and properties, allowing residents to build sense of identity and belonging of community.

6.2 Design Guidelines of Urban Interface

The interface of mega is made by the town school, hospital, large commercial spaces, a headquarters area, government, a stadium and underground space by playing the role of downtown in the level of city. The main industry supports the mega city, business services, public administration and services is also a large city with external information exchange hub.

1. The center of the city interface coincides with the transportation hub thus, the transit-oriented development (TOD). The downtown relies on the subway or rail station where the city is at the foot of the radiation range (500 meters). However, the ground is for the pedestrian layer and the bus ride is in the underground layer so they could achieve the separation of people and vehicles. The architects had set the three underground platforms:

1) Commercial; 2) highway and parking, subway and 3) the floor space are left entirely to pedestrians.

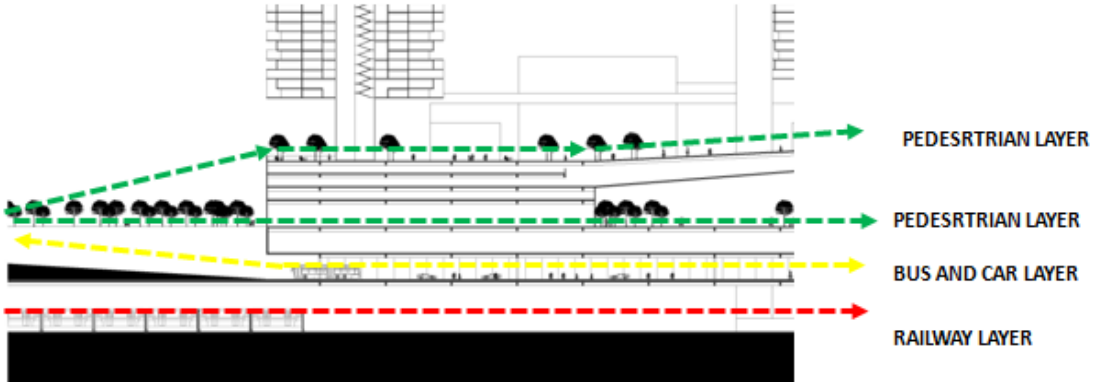


Figure 6.7: Connection with urban transportation system. The underground floor is for the railway.

2. The urban interface should not be a whole but divided into several groups. Each group is about 200-300 meters within a courtyard. There is ample distance between one group and another group to help evacuate and walk through. The platform is connected to the upper layer group.

3. In the urban interface, every group's podium and their towers make up a community. As mentioned earlier, the relationship between a community and the neighborhood is not the hierarchical. The role of the community is weakened is more of a place to rest. We also considered the roof podium as the community club and rest parks. The roof is easily accessible and open to the public with landscape and hills. The roof garden is carefully designed to release the space to sunshine and visions to the residents. Because the FAR is high in the Gaodi Square, the designers used the roof as a garden. Another model of the podium roof is the Namba Park. It is built with staggered space that rises from the street level to 8 stories high, step by step with green lawns as if the natural oasis floats freely over the city (Figure 6.3), in contrast with the surrounding linear building.

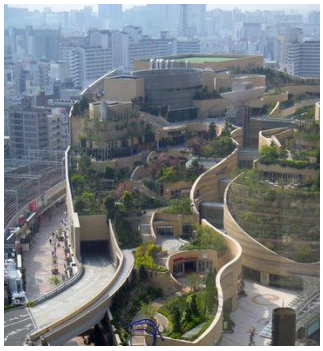


Figure 6.8: Bird perspective of Namba Park, Osaka,Japan, designed by Jon Jerde. The whole roof is designed as a garden for public activity.

Figure 6.9: Perspective of roof garden in Namba Park.

4. In order to set the roof garden, the architect releases the public space in the overhead at the bottom of the towers as well as a community club with open partial floor space (Figure 6.4).

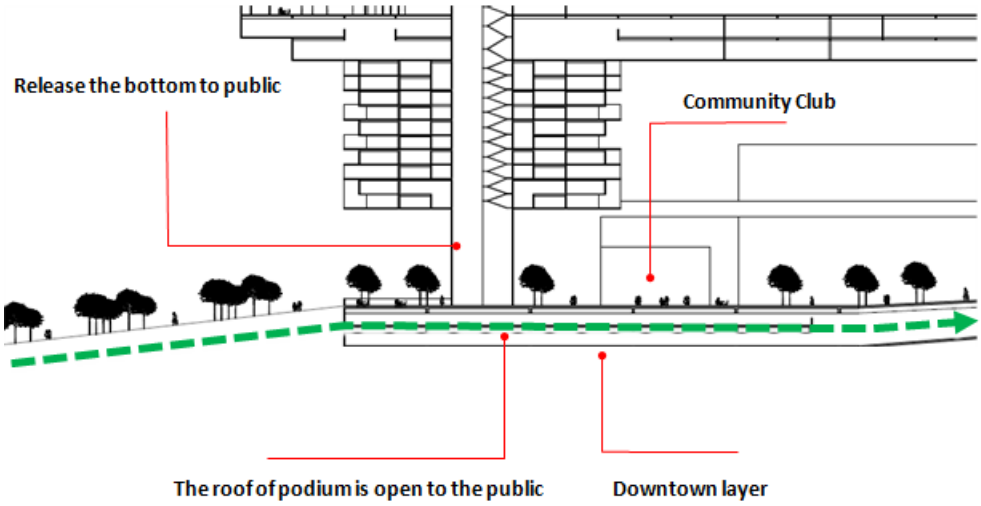


Figure 6.10: The intersection between the towers and roof garden. The architect would release the bottom of towers for public activity.

5. The Group-Form megastructure shares the base facility and infrastructure with the surrounding environment, increasing the vitality and affinity by penetration its boundary. The mall and library of megastructure is opened to the citizen nearby, letting the people thinking the building is a part of their daily life, not just simply extraterrestrials.

Left Figure 6.11: Perspective of Hangzhou Civic Center. Middle Figure 6.12: The bottom space of Hangzhou Civic Center is used for restaurant for people. Right Figure 6.13: Hangzhou Civic Library, also locates in the bottom of Hangzhou Civic Center.

The Citizen Center of Hangzhou is a good example. Designers set the podium part as library, youth palace, restaurant and other public facilities. All of these areas are opened to the public. The people of Hangzhou always visit the center that has now become the landmark in the city.

The podium of Modern MOMA was also designed as a Café, art exhibition and cinema. The designers hoped for it be shared by the city. Unfortunately, after its construction, Modern MOMA became a gated community and changed the real estate for an elite group of people who could afford the residents at high prices.

6.3 Guidelines of Vertical System

6.3.1 Vertical Zones and Public Layers

Megastructure focuses on the combination of life and work. In the horizontal city, the function area is planned in the horizontal dimension. In the vertical city, the functional zone is planned in the vertical dimension. The public functions were both planned near the ground and in the air. The hospital and schools was planned on the ground. The work in the megastructure has a low-pollution rate such as the Office Tower and SOHO, making this megastructure a residential complex, offices and other services.

Otherwise, the vertical function is always in the vertical space. According to the case studies, the restaurants, exhibitions and entrainment spaces are always placed on the connecting parts. The annex is always combined with the commercial and traffic which have a close relationship with the city. The earlier ideas of megastructure, Theodore Starrett came out with the "100 -floor buildings". He divided the 100 floors into 4 layers: 1) the first layer is the industry, 2) the second layer is the office, 3) the residence on the third layer and 4) the hotel was put on the fourth layer. The public spaces such as markets, theaters and other were placed between each layer[36]. This idea has come true today with the Tower of Dubai.

As mentioned above that in order to enhance the community's sense of belonging, it must consider that each vertical partition is set at 12 layers of 15 layers (the basic unit of intimate neighborhood of) in a basic unit (about 100 households). The megastructure adopted the basic elements in the same or similar unit, connecting different public units between the towers through each level system connected to share the infrastructure. In figure 6.8, the buildings are divided into 4 functional zones and form a cognitive neighborhood by connecting the public layers.

[36] Chunfang Dong. *Architecture to High Density(* Beijing: China Architecture & Building Press,2012),73.

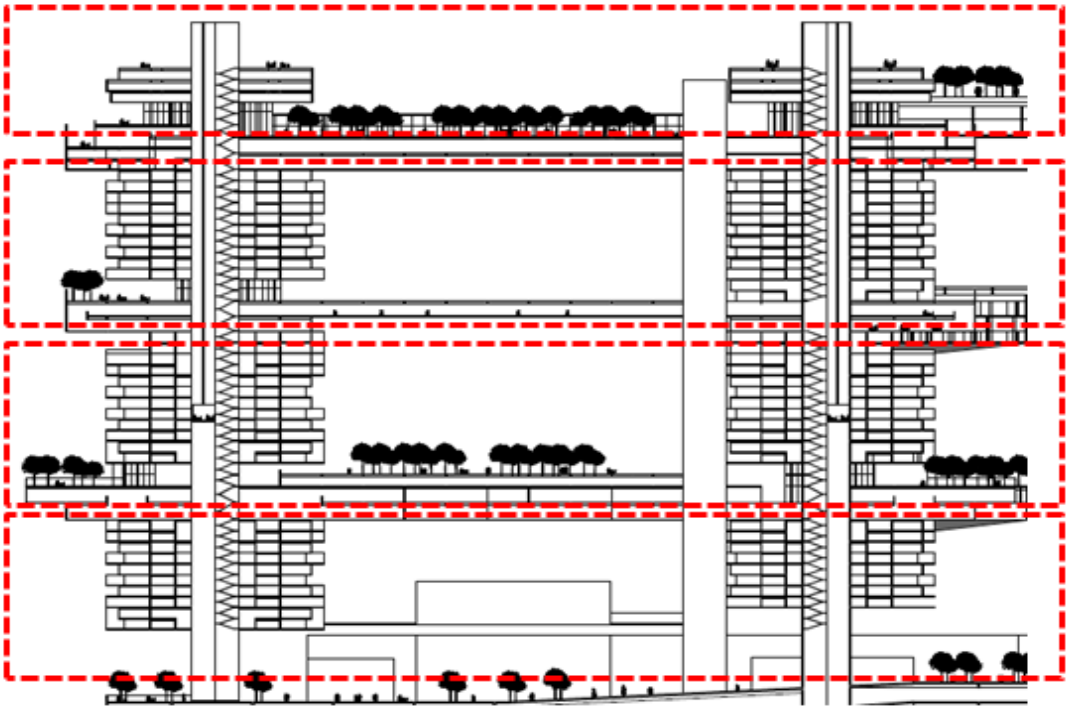


Figure 6.14: Neighborhoods are divided by horizontal dimension, instead of vertical dimension. The vertical function zones and the sky streets make a neighborhood in different height.

6.3.2 Sky Streets and Sky Corridors

The street is the most activity place in the city because streets are combined with businesses and other public functions. In the Marseille Apartment, Corbusier designed an sky street to satisfy the needs of the residences. The design was in the group-form megastructure because of the connection to the buildings and the sky streets providing more possibilities.

The horizontal streets could be divided into two phases: first, the street that is always rich with the urban life and it could be transformed into an sky street. Second, the pathway, though it is also a “street” that is the main function even though it has traffic. It could be transformed into an sky corridor.

Compared to the sky corridors, the sky street is the neighborhood center and part of the function with such spaces as an exhibition center, In the Modern MOMA, a series of connection creates a public space but the function is not for urban activity. It is regarded more as “sky corridors” than ”sky streets”.

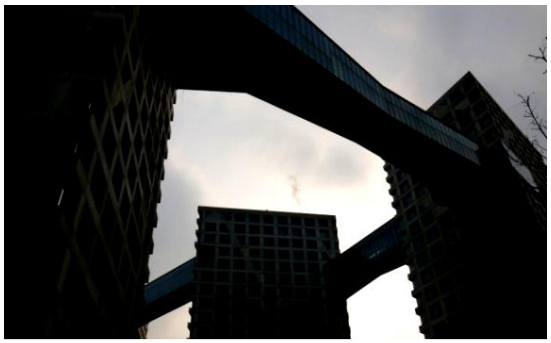
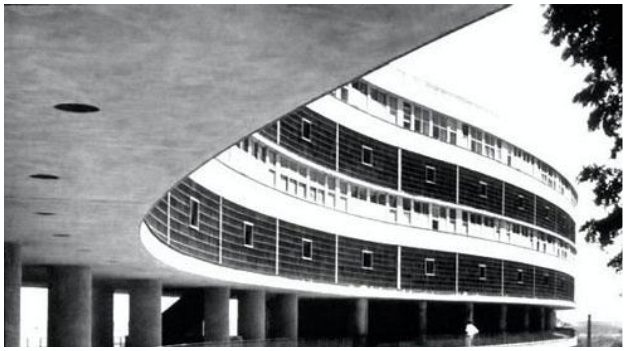
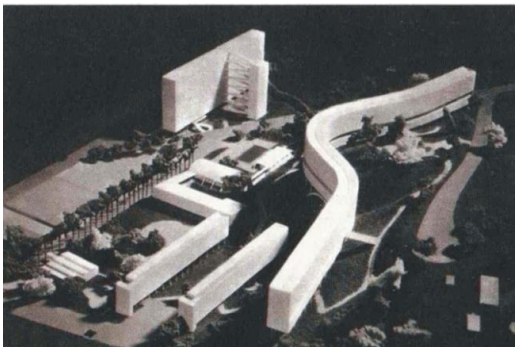



Figure 6.15, 6.16: Sky corridors of Modern MOMA.

Solution 1: Suspend. Designing the streets to become sky streets allow for one floor to be converted into a public space. Architect Alfsonleidi designed the Pedregulho Village with linear vertical elements based on the sky street.

Left: Figure 6.17: Inaugurado o Conjunto Pedregulho, designed by Affonso Reidy,1952.
Right: Figure 6.18: Sky street in Pedregulho.

Solution 2: Connect. Connecting to the sky street is universal that connects to an sky street. The connections have a functional meaning. In the Modern MOMA designed by Steve Holl, a series of streets between 12 floors and 18 floors connected the towers into a whole and created a series of public spaces. They were used for swimming pools, Cafés and galleries. The connection became the center of whole neighborhood. The functions included the kindergartens, service center for seniors, small businesses and a commercial center, neighborhood clubs and a committee. The life of the inhabitation is connected to the city closely. The horizontal system of the community is in the same height while different communities can be connected by sky corridors. The whole mega is dived into 3-4 layers, each layer could set a directly transportation to the ground.

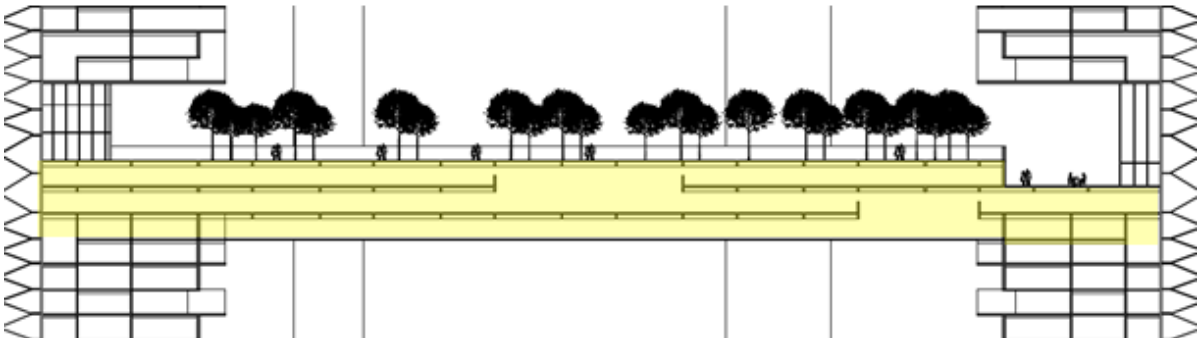


Figure 6.19: Sky streets of Group-Form Megastructure. The streets could afford urban function, such as restaurant, neighborhood club and entertainment etc.

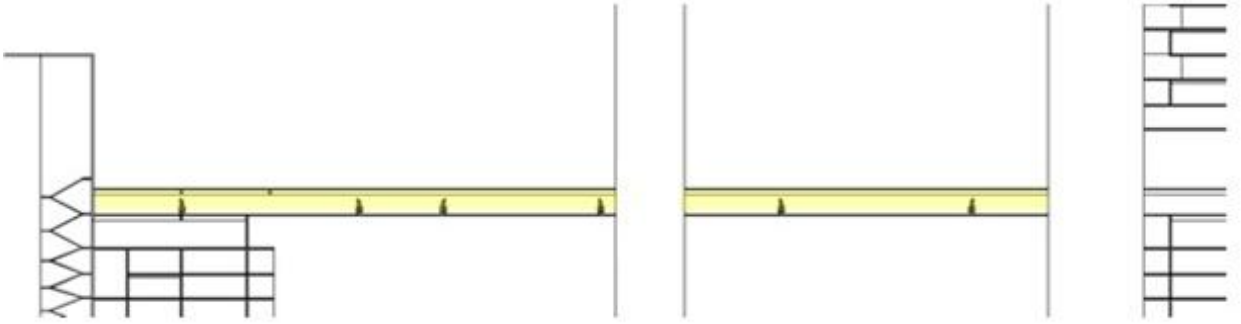


Figure 6.20: Sky corridors of Group-Form Megastructure. The main function of corridors is for walk and evacuation.

6.3.3 Secondary Ground

The people have the natural characteristics to want to touch the sunshine but living high of the ground for long period in time would be very uncomfortable. Therefore, we need to design the secondary ground in the air and provide space for residential activities. The difference with sky street is that the secondary ground does not require increased functions to be opened to the public. It could be a line or plane that is usually provided by the sky street or corridor to the roof (Figure 6.21).

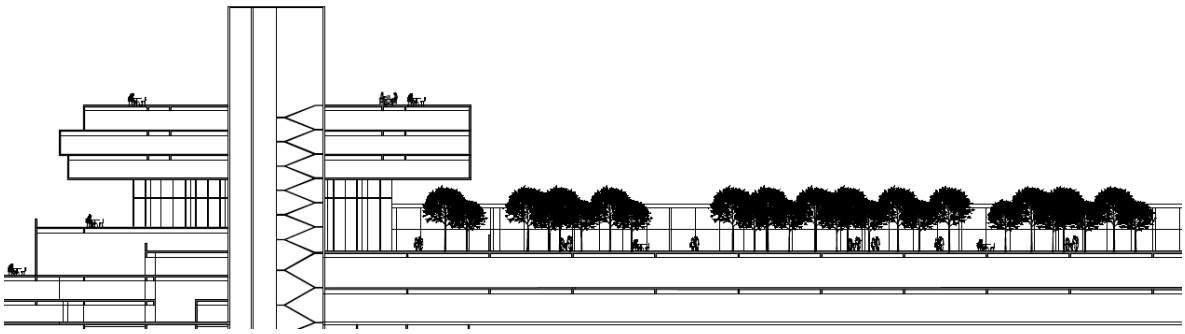
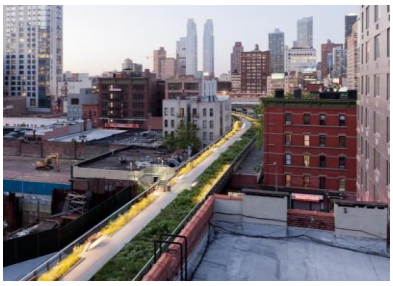
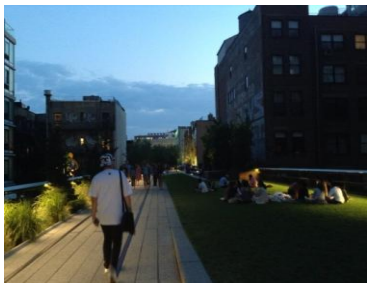


Figure 6.21: Secondary ground. The secondary ground relies on the roof of sky streets, providing a neighborhood park for inhabitants.

Another famous case of linear public space is the Highline Park. Built in 1930, it was a roadway that became abandoned in the 1980s. Since 2003, the government of New York claimed to rebuild it and made a famous sky corridor. The High-Line Park is not only a linear space but understood as a linear series that has several points of public spaces. It expands from a small square or small public green space in the node that these places in small squares tend to become very dynamic.


Left :Figure 6.22: Bird perspective of High-Line park. Middle: Figure 6.23: Roof garden of High-Line park.
Right: Figure 6.24: People rest in sun along the High Line park.

The Square and park is used for public resting and meeting places in the horizontal dimension. In the traditional high-rise buildings, it lacks the possibility to provide large public spaces in the vertical dimension. In the Group-Form megastructure, the square and park could be placed by the roof near the tower and annex. For instance, the Marina Bay Hotel's roof is approximately 10000 square meters. The air park has gardens, restaurants and swimming pools to create a complex landscape system. The square is divided into green spaces, gardens and restaurants and is the most active place in the hotel.


Left: Figure 6.25: Plan of roof garden in Marina Bay Sands.
Right: Figure 6.26: Section of roof garden in Marin Bay Sands.

In the existing buildings, the most successful secondary ground is the Pinnacle@Duxton Apartment. It has two sets of different heights for the sky street on the 26th and 50th floor. It is wider than the buildings and is divided into small spaces to attract the residents' activities.

Sometimes, the people feel they are living in a limited height restriction rather than in a super high-rise.

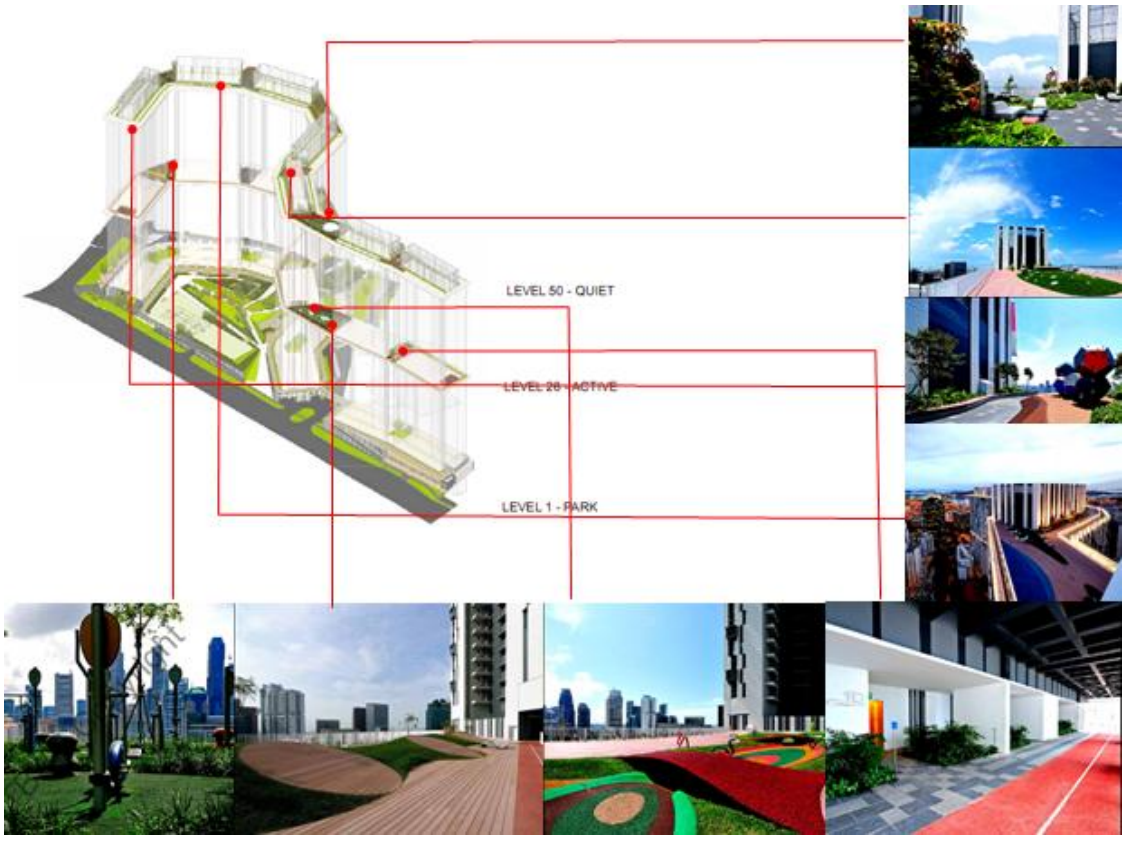
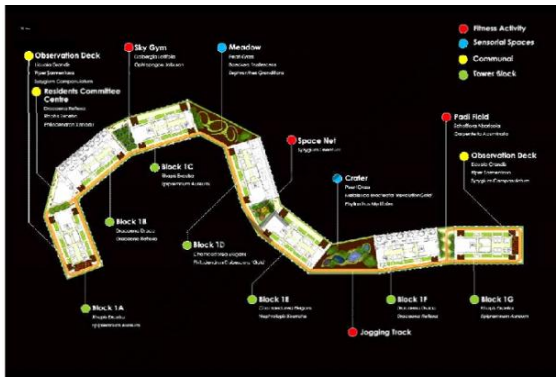


Figure 6.27: Analysis of sky street in Pinnacle @ Duxton. The sky streets could be divided into a series of humanized space, such as sky gym, meadow, deck and green land. Small space of 25th floor: Sky Gym, Meadow, Crater, Logging Track. Small space of 50th floor: lounge, Hill Rock, rocky deck, beach, green lands.



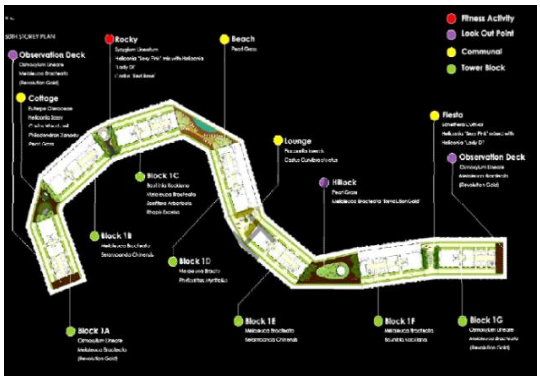


Figure 6.28:25th Storey Plan in Pinnacle @ Duxton. Figure 6.29: 50th Storey Plan in Pinnacle @ Duxton.

6.4 Traffic System

6.4.1 Introduction

In the past, the horizontal sprawl was always in the main direction of the urban development and the horizontal movements such as walkways, private driving and public vehicles were the basis. However, the emergence of megastructure is challenging the facts. Megastructures changed from overcoming the frictional force into overcoming into gravity such as the express elevators, vertical transportation and horizontal streets are now becoming the new grid for the city.

In the existing horizontal urban mode, the different communities are parallel. The daily radius of people's activities is limited into 1KM which a scale of communities. Therefore, the people's daily life is always part of the community's scale and still lack communicating with other communities. Otherwise, the boundaries of the communities still are distant with communication making it difficulty. When the flat city is folded, the daily activity radius expands and the entire city is within people's walking distance. As the complex traffic system increases the people's communication and the boundary disappears.

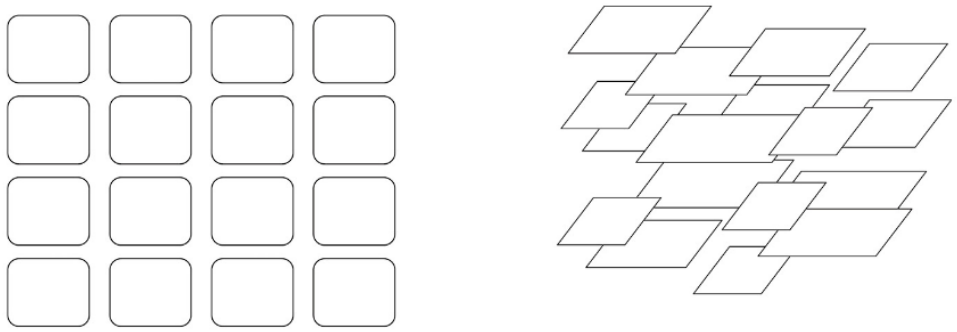


Figure 6.30: Comparison of traditional horizontal traffic mode and Group-Form Megastructure's traffic mode. In the traditional mode, it is easy to make isolations between different communities and neighborhoods. In the Group-Form Megastructure, the traffic system is easy to make communication happen and the boundary is disappearing.

As an important part of urban system, the traffic system is not only the vertical elevator system but involves the details in three perspectives.

6.4.2 Consideration of Vertical Transportation

1. Combination of express elevator (point to point) and normal elevator (stop by stop): The high--speed characteristic of the elevators reduces communication time of residents in the neighborhood. With the higher floors, it is easy to see there is a waste of time and resources. In the architectural design of mega, we introduced some express transportation to achieve some of the ideas. There are two kinds of elevator system: 1) stop floor by floor and 2) stop by

the public layers. These public layers are always placed where public activities are located and has the characteristics that serves the public.

Modern MOMA and the Pinnale@Duston both adopted the model with express elevators that could reach the public layers directly. The Shanghai Center used this model. In the design of Shanghai Center, there are vertical zones in the traffic system. The people could reach the transfer layer from the ground and continue directly to every vertical zone. Here, some people could change into the normal elevator to arrive at even floors in the zones reducing the pressure of the whole skyscraper.

2.Combination of high speed transportation and slow transportation: In the existing flat city, the walk is not only a traffic way but possibly a social gathering. The space in the elevator is limited and the speed is fast but it separates from the social characteristics. In the future, the public space could be designed larger that would slow down the speed in some special elevators. They are not only used as traffic tools but also a place where people eat and drink and become special places attracting tourists.

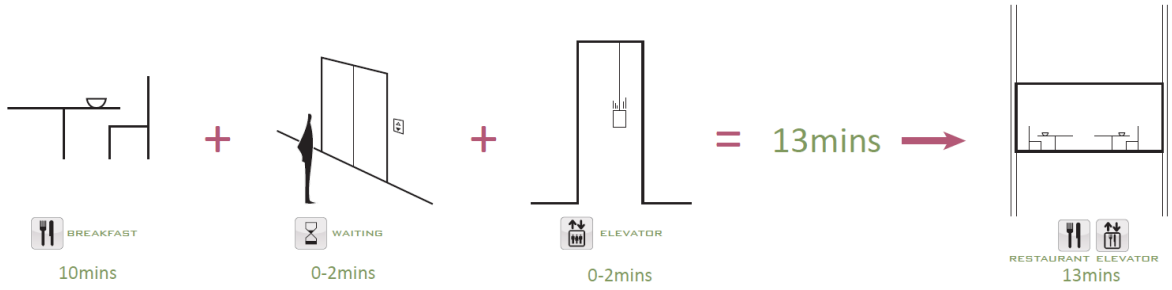


Figure 6.31: Diagram of slow elevators. The slow elevators would combine with the restaurant or café, becoming an attractive place for tourists.

3. Change from vertical direction into multiple directions: With the development of technology, the elevators are not only vertical, but also present multiple directions and multiple angles, especially in some very important layers. Beside the exterior stairs, there are also stairs in the core. Stairs are encouraged within the neighborhood. There are also special freight elevators.

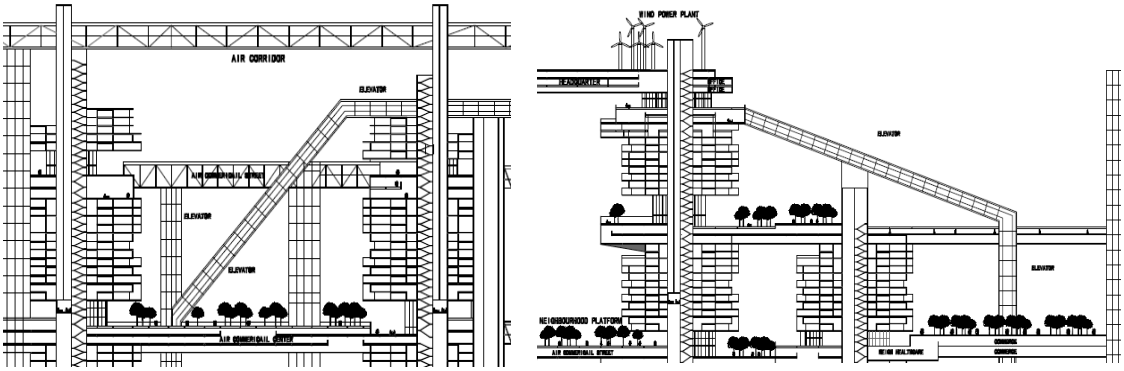
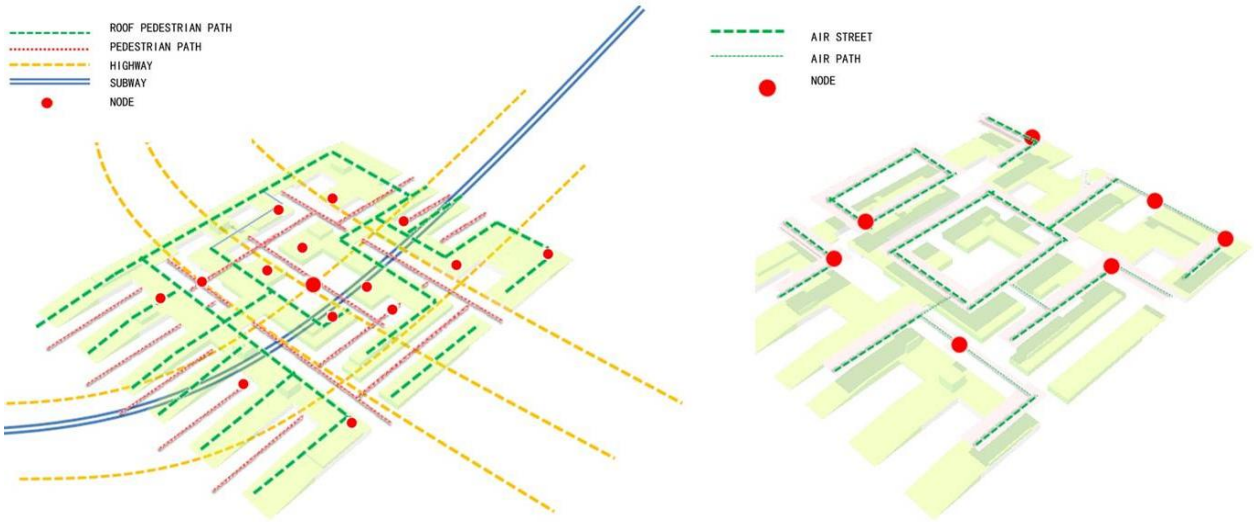


Figure 6.32, 6.33: Multiple directions' elevator to very important public floors.

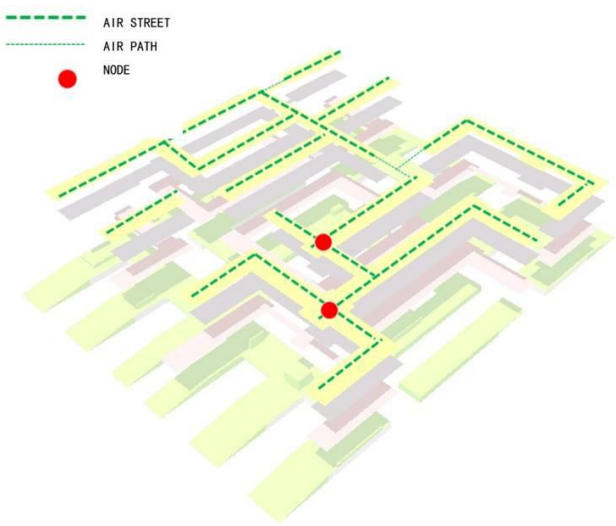
6.4.3 Horizontal Traffic System

Since the emergence of horizontal connections, horizontal traffic also become the main traffic way. The difference from the vertical transportation is the horizontal traffic relies on walking. Because of the three-dimensional space, the vertical space and horizontal space become a whole forming three cycles in different heights. There are vertical elevators and oblique elevators between the cycles to promote the connections.

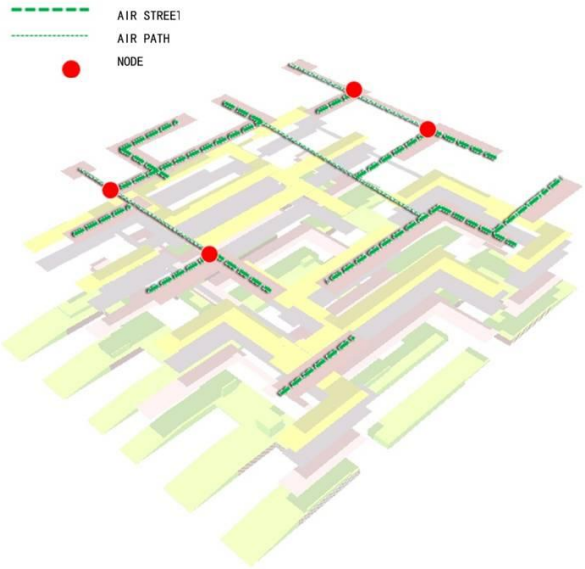


Left Figure 6.34: Traffic analysis---the bottom of Group-Form Megastructure connect with the urban railway system and highway.

Right Figure 6.35: Traffic analysis---first cycle.



Left: Figure 6.36: Traffic analysis-the second cycle.



Right: Figure 6.37: Traffic analysis-the third cycle.

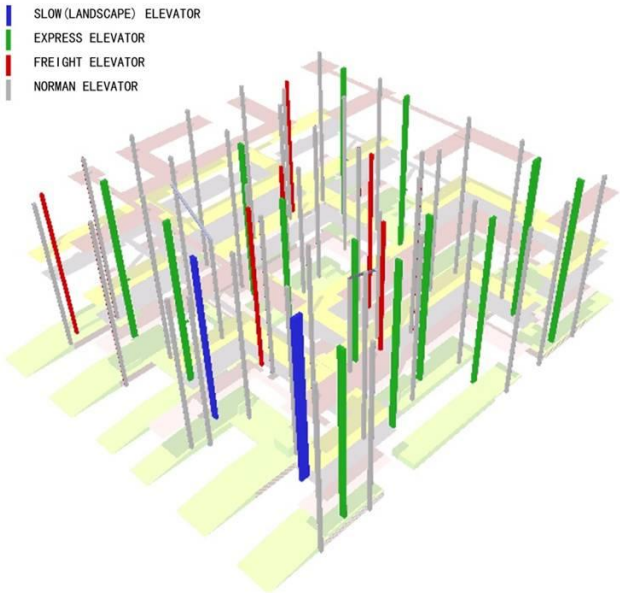


Figure 6.38: Traffic analysis-the vertical transportation

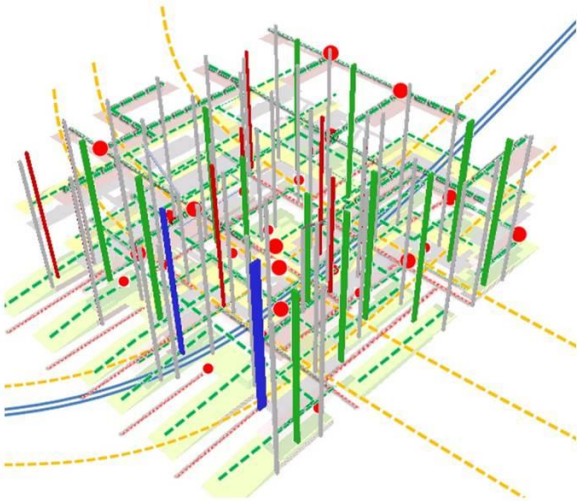


Figure 6.39: Traffic analysis-the vertical transportation.

Three cycles are important in the urban public space, encouraging walking. The horizontal escalators and unicycle electric vehicles also are encouraged. The ground floors and roof floors of the podium of a megastructure are open to walking and bicycling. The vehicle layers are set under the ground reducing the interference of vehicle. In fact, in the existing urban development mode, the similar horizontal system has emerged in Asia, especially in Hong Kong. As a super high density metropolis, Hong Kong reflects part of influence by megastructure. In the urban

design in Central, Hong Kong, architects form a horizontal pedestrian system by the corridors which close to ground. The system form a ring around the buildings, integrating urban flow into high-density commercial systems, and it could be seen as an early form of the Group-Form Megastructure.

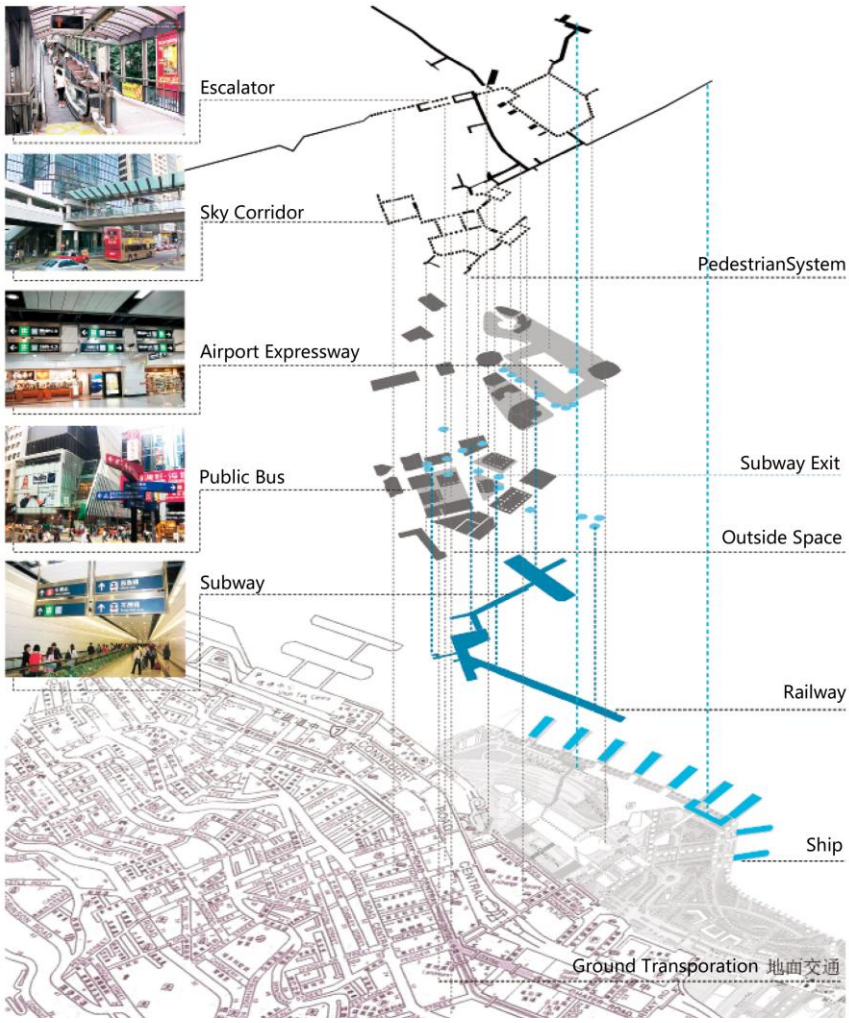


Figure 6.40: Traffic analysis of Central, Hong Kong.

6.4.4 Connect with the Urban Traffic

There are three main ways to arrive in the group-form megastructure of the residents outside the city: 1) public traffic, 2) private cars, and 3) the railway system. To reduce the interference of vehicle, all of the urban traffic is located underground. Vehicles arrive in the underground layer by a long ramp, connecting the underground garage. The railway system is also located at the lowest level of transportation. The vertical core reaches the urban vehicle

layer and railway system so the people could enter the megastructure directly after they park their vehicles. In addition, the underground traffic layers can combine the commerce and catering spaces, therefore, becoming an important part of downtown.

The combination with urban transportation system is comprehensive. Through the integration into a large urban transport system, the accessibility of megastructure would be promoted. We can learn from the vertical connection also in Central, Hong Kong. Sky pedestrian system integrates underground space. The underground space is used as shopping malls, underground tunnels, subway stations, ground pedestrian system, public transportation, taxis, boats, walking floor and sky systems, public transportation, taxis, steamers, and sky pedestrian system connection. From the ground floor to up, it followed by the order of commercial, office and inhabitation.

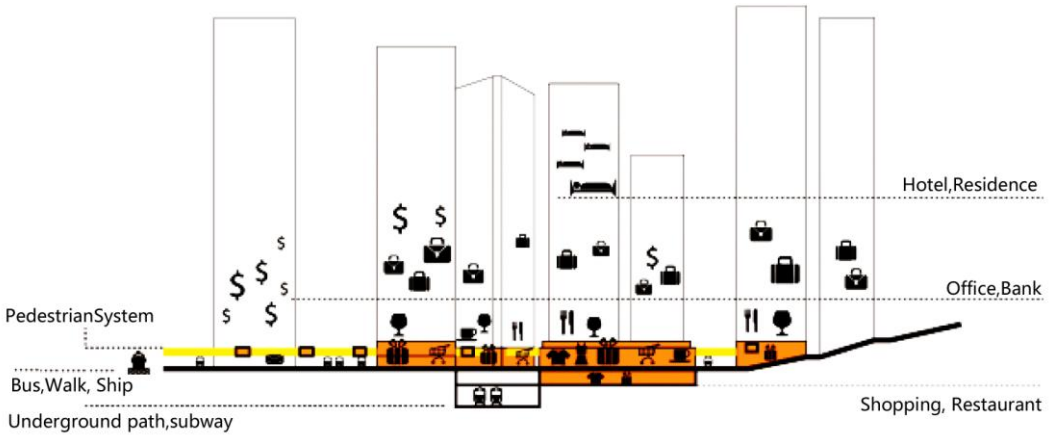


Figure 6.41: Section of Central, Hong Kong. The underground space is used as shopping malls, underground tunnels, subway stations, ground pedestrian system, public transportation, taxis, boats, walking floor and sky systems, public transportation, taxis, steamers, and sky pedestrian system connection. But comparing with Group-Form mega, it lack the connection far from the ground.

In addition, different from the flat city, the emergence of sky streets and private sky transportation make the ways which the people enter the mega diversity. Megastructure should be set up helicopter platform, considering the possibility of residents directly into the megastructure from the top, which also could become one of emergence evacuation measure. In the existing high rise city, the floors close to the ground have the higher value. As the sky street appears, the value changes from the high to low from the down to up into more equal.

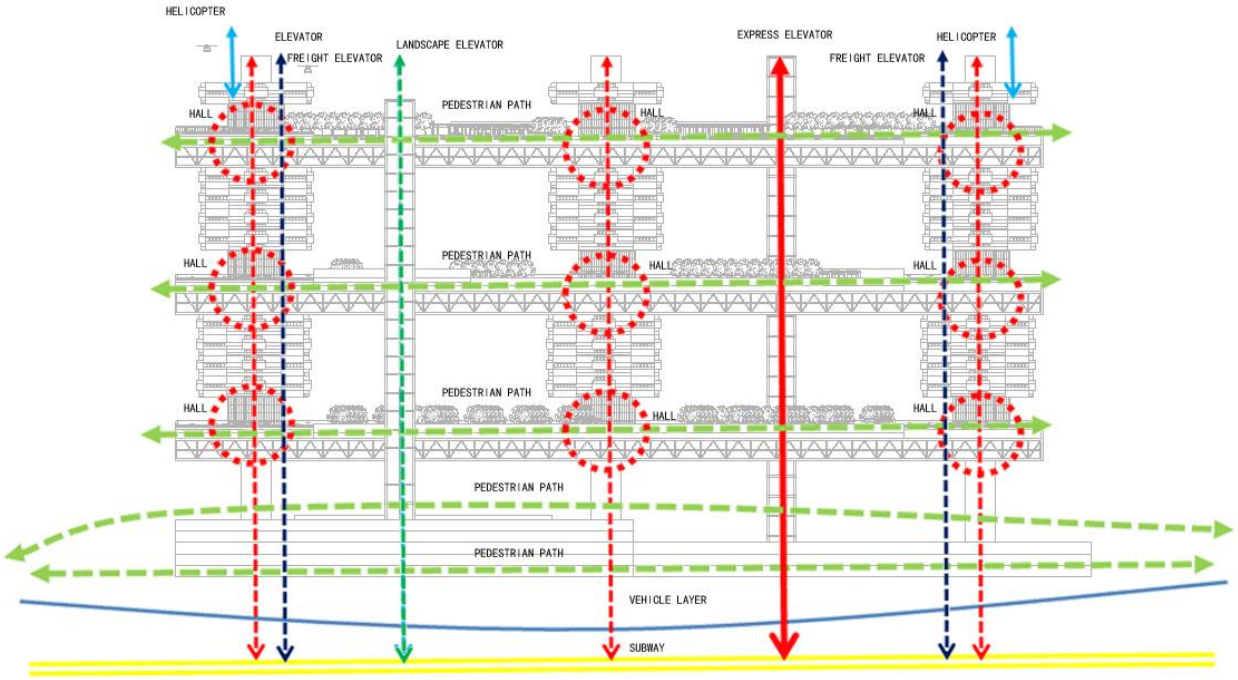
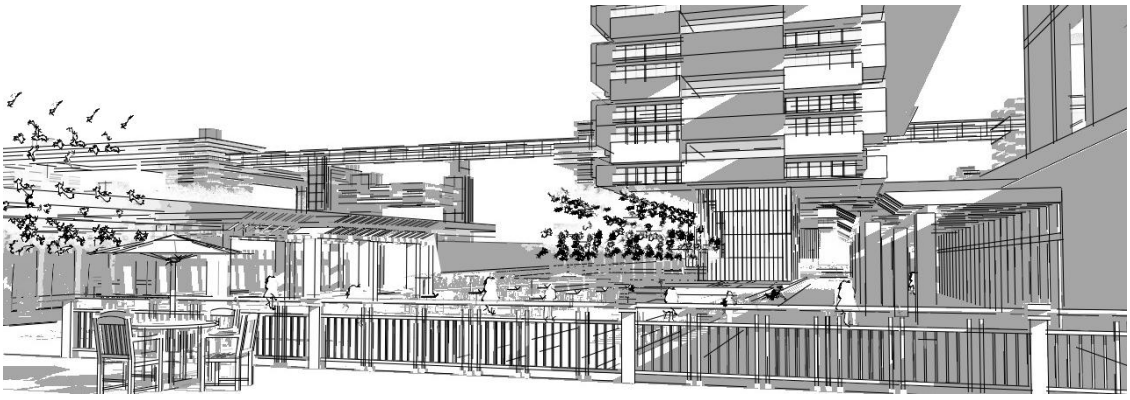


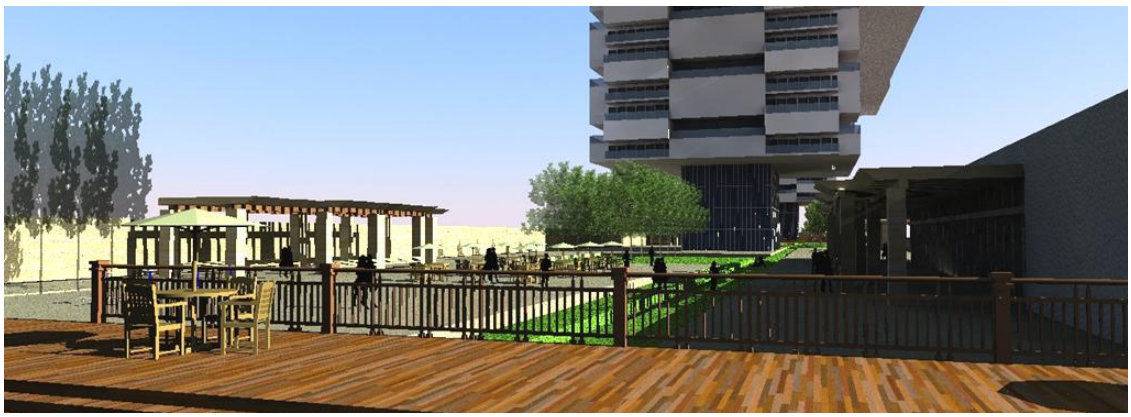
Figure 6.42: Traffic system section. The underground layer is for urban railway system, the vehicle layer is also put under ground to make the ground layer for walk and bicycle. The roof of podium is also accessible by slope. The whole megastructure is divided into 3-4 layers in different height. The vertical transportation which connect the different layers could be divided into normal evaluators, slow elevators and express elevators. The people also could enter the megastructure from the roof layers by helicopters.

6.5 Design guideline for Sky Streets and Secondary Grounds

Sky streets and secondary grounds are inseparable. The secondary ground is usually made by the roof of sky streets. They rely on each other from the perspective of form and function. They could be divided into:

1. Neighborhood units: It is mainly applicable in the general neighborhood. The sky street is used as the management of neighborhood, community nurseries, elderly care centers, community businesses and restaurants. The main function of the secondary ground is for rest, and it could be divided into grass, hard pave, wood deck, combining with construction and small buildings, and become an important platform for people to live in the air. It becomes a public place for the whole neighborhood. It is convenient for the residents to enter the air neighborhood center and platform by the horizontal connection and also connected to the downtown by the express elevator.





From top to down:

Figure 6.43, 6.44: Perspective 1 of neighborhood unit both in line style and in rendering style. It could be divided into grass, hard pave, wood deck, combining with construction and small buildings. Source: made by Xu Yang.

Figure 6.45,6.46: Perspective 2 of neighborhood unit both in line style and in rendering style.

2. Commercial units: The sky streets are used as shopping mall or supermarket. Their secondary ground is similar with the neighborhood units, and also used for rest. It need to add some small business buildings on the secondary ground as additional part for the bottom business.

3. Entertainment units: These units are on the roof of mega. The sky streets functions at upscale clubs and restaurants. The vertical parts are located on the secondary ground that is set as a hotel. The entertainment units are the most active part in the mega becoming an important place to attract tourists.

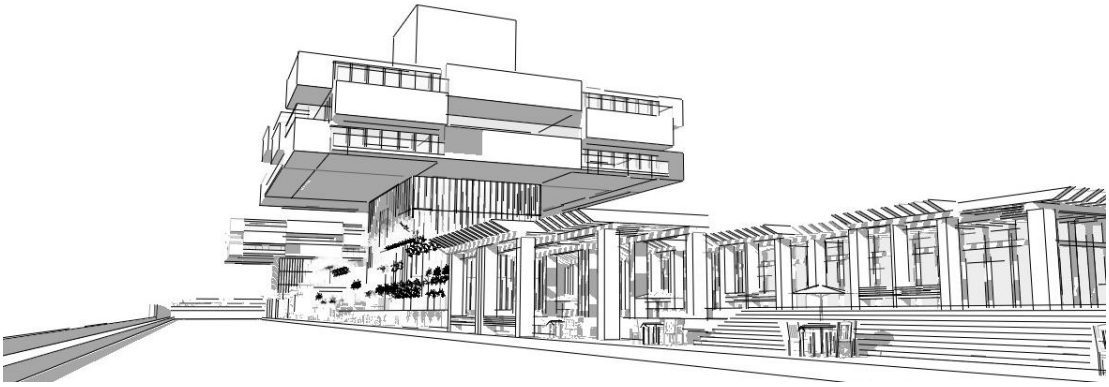


Figure 6.47, 6.48: Perspective 1 of entertainment unit both in line style and in rendering style.

Figure 6.49: Perspective 2 of entertainment unit in rendering style

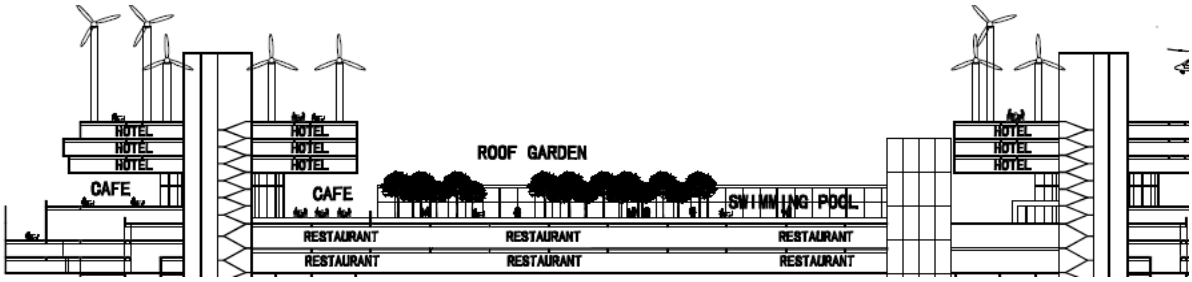


Figure 6.50: Section of entertainment units' secondary ground. Source: made by Xu Yang. The functions of sky streets are mostly clubs and restaurants for rich . The vertical parts above the secondary ground are set as hotel. The entertainment units are always the most active part in the mega, becoming an important place to attract the tourists.

Figure 6.51,6.52: Perspective 3,4 of entertainment unit in line style.

4. Special units: These units are schools, sport courts, stadiums and other activities. The secondary ground is only opened to the sky street users, such as playgrounds, rest venues. Residents cannot arrive to these unit by the external vertical transportation.

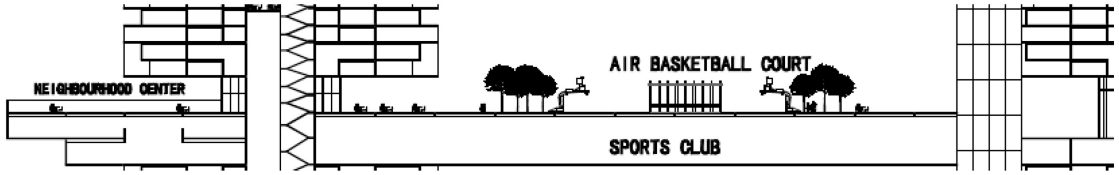


Figure 6.53: Section of special units.

Figure 6.54,6.55: Perspective 1 of sky basketball court both in line style and in rendering style.

Figure 6.56, 6.57: Perspective 2 of sky badminton court in both line style and in rendering style.

In the design of sky streets and secondary grounds, the following tips should be noticed:

1) Vacant intersections: residents' public hall is located at the intersections of horizontal the parts and vertical parts that are places of public activities. The architects design the vacant intersections by combining café and tea houses with the neighborhood committee's clubs.

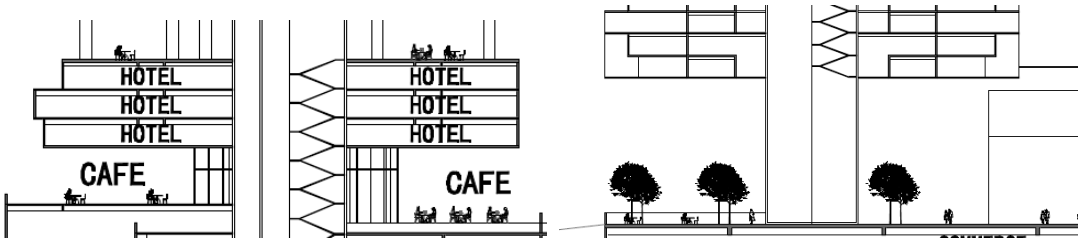


Figure 6.58: Make intersection vacant for public activity.

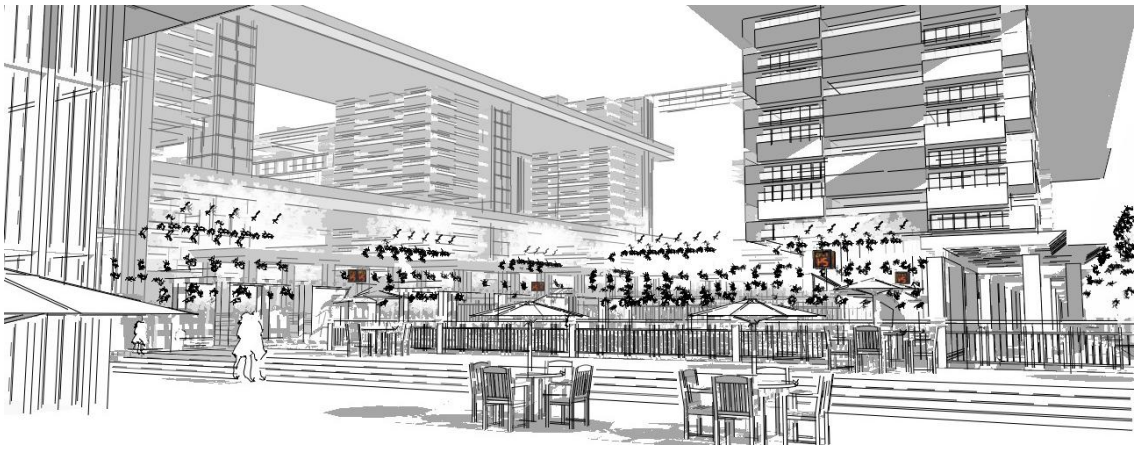


Figure 6.59: Public platform for rest.

2) Division of space: The secondary ground cannot be a simple platform but it could be divided into a series of small spaces by materials, various heights and other solutions. It is able to increase the space levels by providing small buildings and construction.

3) Expanded nods: The nods on sky streets are expanded into the public square.

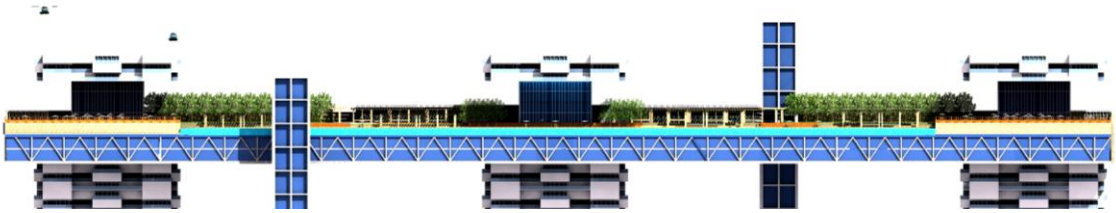


Figure 6.60: Façade of sky street.

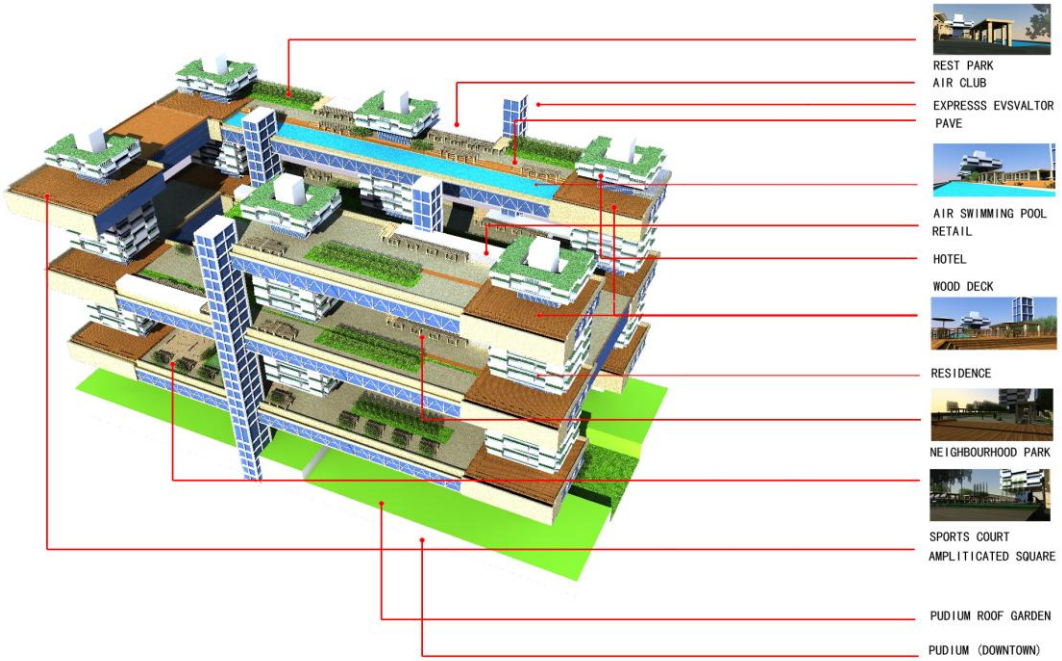


Figure 6.61: Sky streets and secondary ground---Division of space.

4) Diversity of traffic methods: The architects increases the express elevator by leading the people to enter the sky streets and secondary grounds easily. The express stop is for the public layers. The top of mega is designed as the platform for helicopters and other possibilities for air traffic. In the vertical traffic, the architects increases the slow traffic by combining the vertical traffic and catering that is an attractive part of mega.

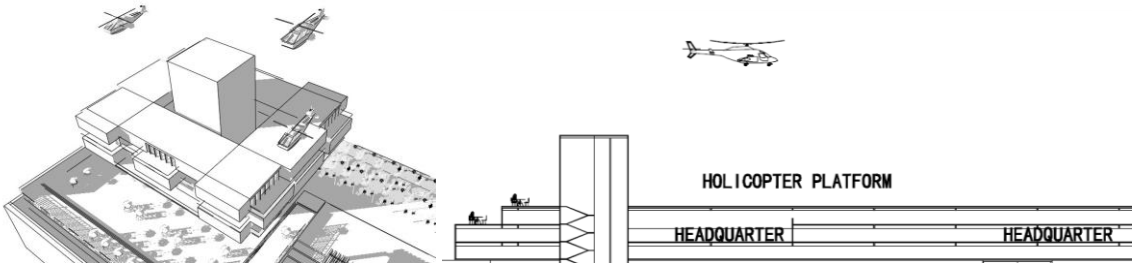


Figure 6.62,6.63: Diversity of traffic methods. The roof could be set as helicopter platform and people could enter the megastructure by helicopter.

5) Safe and vision: The specialty of the sky streets and secondary ground is their height. Architects designed for the safety of the residents when they are enjoying the beautiful landscape in the air. Therefore, some parts of the secondary ground should use the high parapet to ensure the safety, Some places that are opened to the viewing deck then an extension with a low buffer space could be used as a parapet as shown in Figure 6.64.

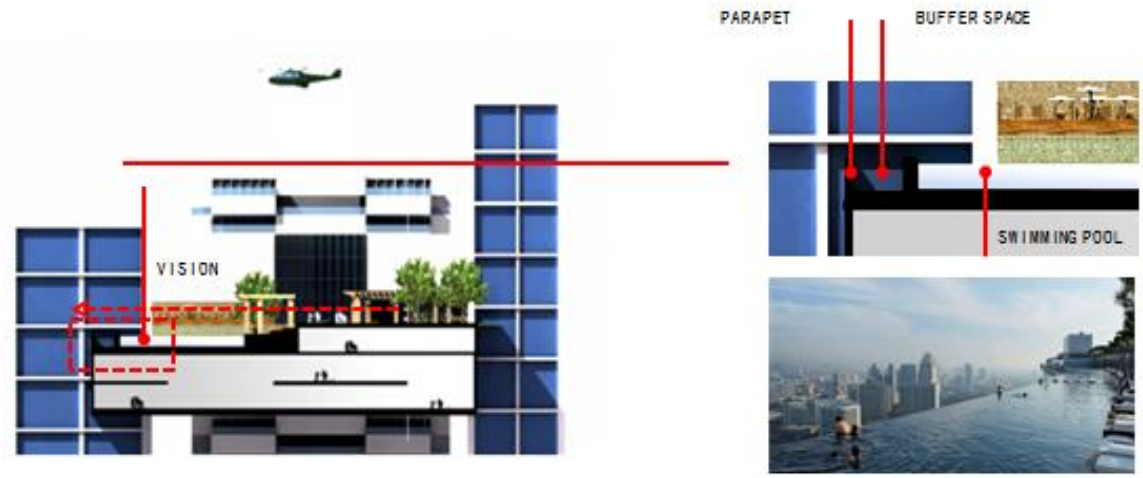


Figure 6.64: Safety and vision. The roof extended to a buffer but low space to be used as parapet, to satisfy the vision meanwhile ensuring safety.

6) Diversity of section: These sections are not simple layer space but provide diverse spaces by the courtyard, atrium and ramp.

7) Feasibility of structure: The horizontal parts are prefabricated on the ground and plugged into the interface using a truss system (Figure 6.65).

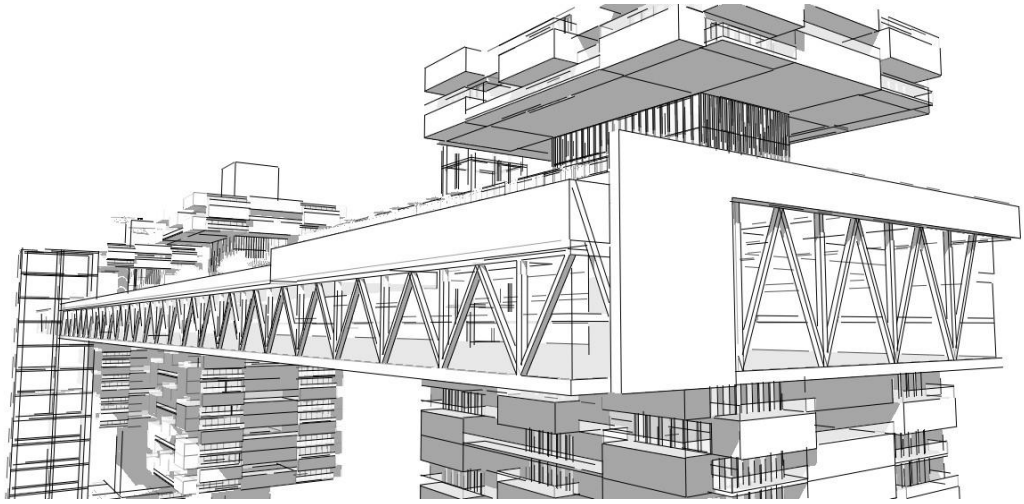


Figure 6.65: Truss structure of sky street.

6.6 Classification of Public Space

In traditional cities, the level of daily space is very diversity. But with the development of modern high-rise city, people always feel the scale of community level, lacking the feeling of human scale. The public space system loses the balance of scale. When we encourage public communication, we cannot ignore the protection of privacy, especially in the megastructure where the residents' distance is highly concentrated. The megastructure should build a clear public structure to meet the need of public communication and protect the privacy at the same time. Their public characteristics are always decided by the transportation accessibility.

Urban Public Space: including the podium of mega, as well as a part of sky streets (such as commerce sky streets, sports sky streets, etc.).Their accessibility is very high and residents can enter them by walk or express elevator.

Community Public Space: The roof is the podium. The community public place is not a very important place in the mega and it is took place by the neighborhood public place.

Neighborhood Public Space: The sky streets and secondary grounds are always set for the neighborhood public space. The residents could enter them by the vertical elevators of towers. There are also some expressway elevators or oblique elevators between neighborhood public places.

Semi-Public Space: Every hall is the vertical zone. They are not open for the public. There are access control system and they are just open to residents in the same neighborhood.

Semi-Private Space: Such as the atrium or courtyard in every vertical zone. They could be arrived by the stairs or floor-by- floor elevators and they serve for 2-3 floors residents.

Private Space: Resident units.

Special Traffic space: could be divIded into public special space, includes the subway station, transfer layers of vehicle. They are also combined with commerce and belong to urban public space.

Semi-Public: express elevators or landscape elevators, serving for urban public space and community public space.

Semi-private: stair freight elevators or normal elevators for residents.

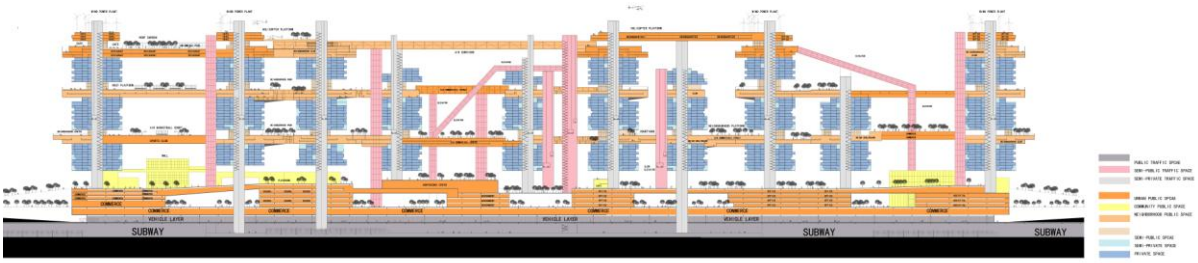


Figure 6.66: Public space system. There are a series of different kinds of public space, including urban public space, community space, neighborhood public space, semi-public space, semi-private space and private space, to make diverse public space system.

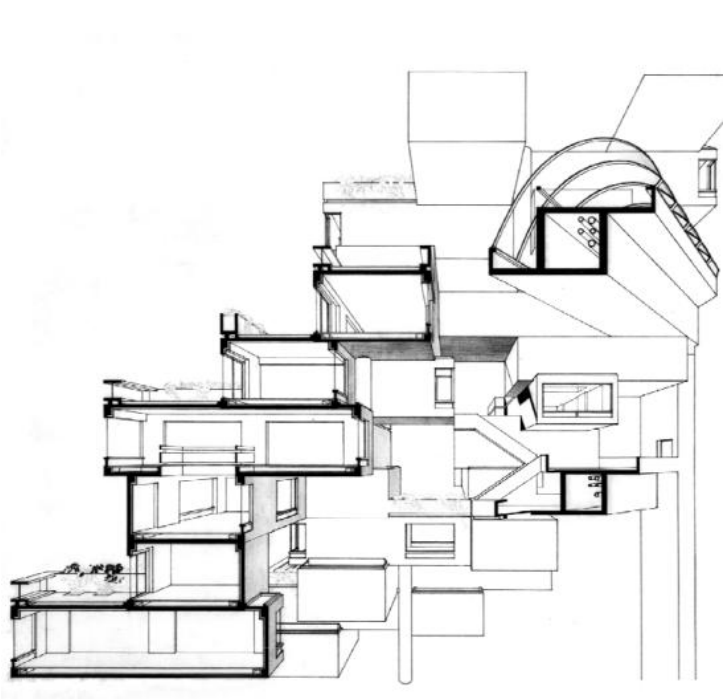
6.7 Guidelines of construction

6.7.1 Modular and Industry Construction

In 1968, Ralph Wilcoxon published an article about megastructure that the units of mega could be plugged-in or clipped-onto the framework after fabrication. If the buildings are too large and common building methods are inadequate then we should use the modular prefabricated assembly with industrialized construction methods. Many architects have already explored these methods.

"Habitat 67" was one of the largest spots in the 1967 Montreal World Expo. Though the scale was not huge, the concept of modular applications could be seen as a landmark in the history of megastructure. Architect Safdie took full use of the spaces in the crowded city. He took the small units of the honeycomb structure and maximized the space to ensure every

family could enjoy the sunshine and fresh air. It would guarantee the basic privacy at a low cost and satisfy the public' needs. However, fact is the demand for the building's units has made them more expensive than originally envisioned. These units used 354 prefabricated concrete forms arranged in various combinations reaching heights up to 12 floors. Together these units created 146 residences of various sizes and configurations that each form came from one to eight linked of concrete units. Originally the complex contained 158 apartments but several apartments had since joined together to create larger units while reducing the total number. Each unit is connected to at least one private terrace, which can range from approximately 225 to 1,000 square feet (20 to 90 m2) in size."[37]



Left: Figure 6.67: Section of Habitat 67, Moshe Safdie,1967. Right: Figure 6.68: Construction photo of Habitat 67.

6.7.2 Process of Construction

Megastructure system is composed of 3 parts, the vertical transportation core (this is the main part of the mega structure system), prefabricated residential units finished in engineering precast, then hoisted in the air and the public layer reserved in advance for a good position. The level of air system is first assembled on the ground, and then inserted into the reserved

[37] "Habitat 67", accessed by May 8th, 2014. http://www.habitat67.com/concept_en.html.

interface. The unit construction is based on defining the basic units that can provide a variety of apartment layout according to the change of the family structure while meeting the demand of changes and migration. Because of the long-term construction process of the megastructure, this style of building needed to meet the growing demand. We should need determine the reserved interface between the vertical transport core and public level system, can change slowly and construct in a number of years.

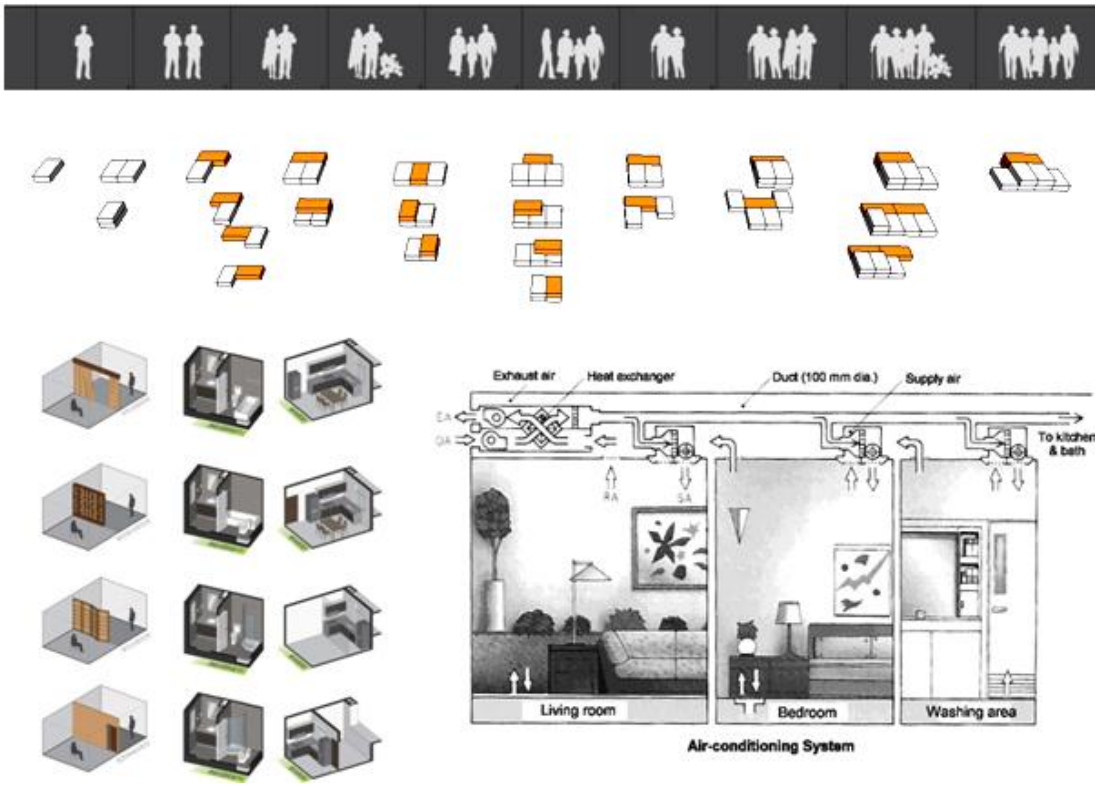


Figure 6.69: Family structure's modular change. Every family could be made by modular units, and it could change with family's structure changes.

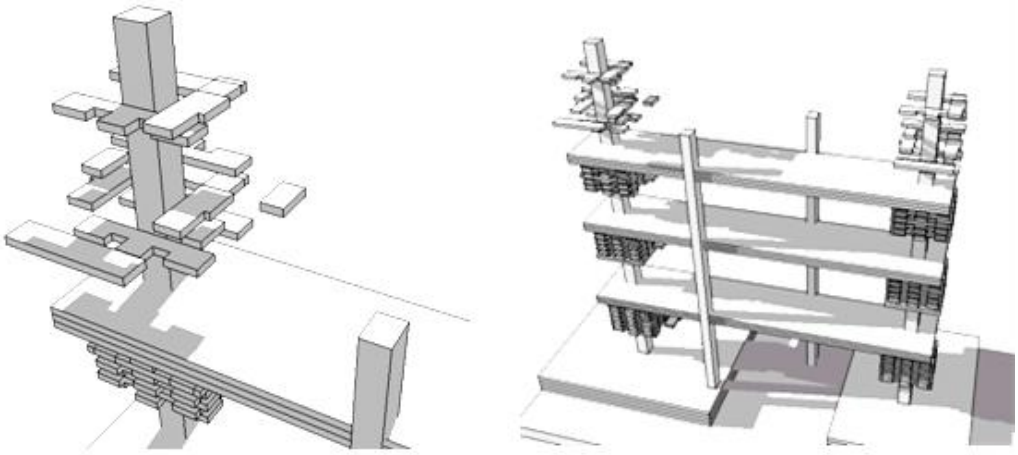


Figure 6.70: Construction process of megastructure.

Figure 6.71：First step, plan MTR lines, and build subway and underground layer.

Figure 6.72: Second step, build large-space layer, large commercial space and stadium.

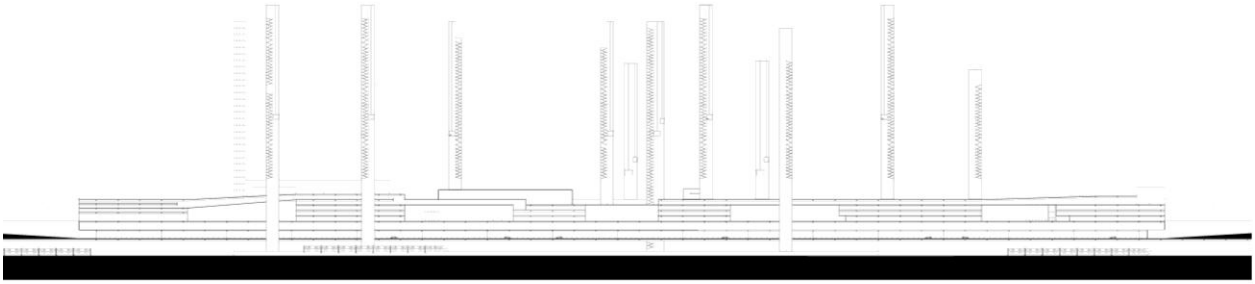


Figure 6.73: Third step, build vertical transportation core.

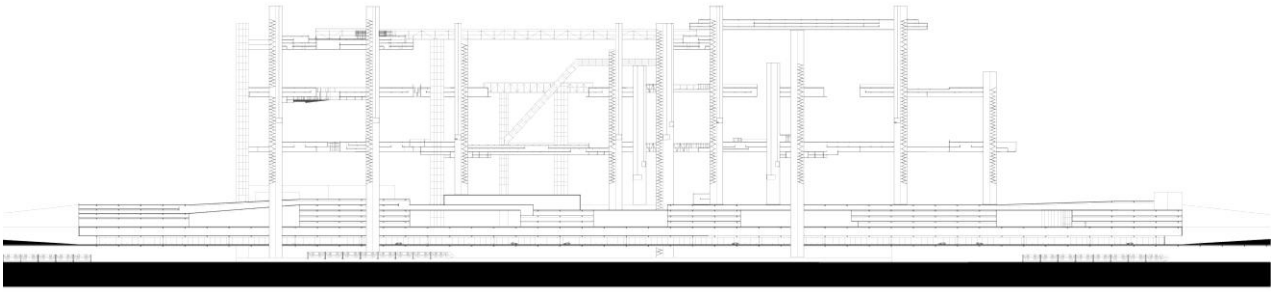


Figure 6.74: Forth step, prefabricate level system and hoist.

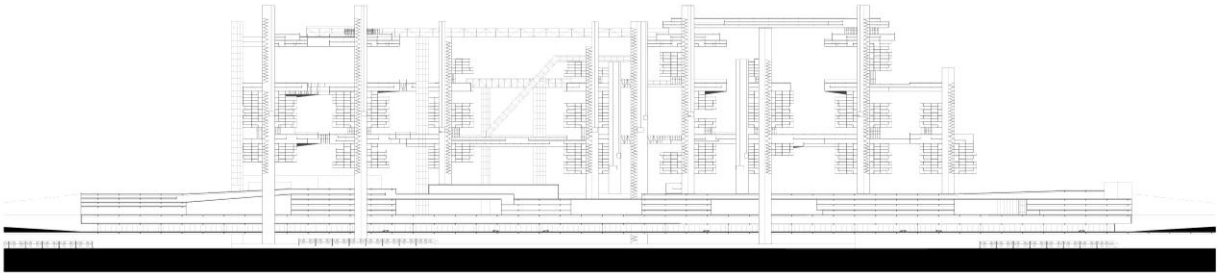


Figure 6.75: Fifth step, plug in residential units based on the changing of cities' scale.

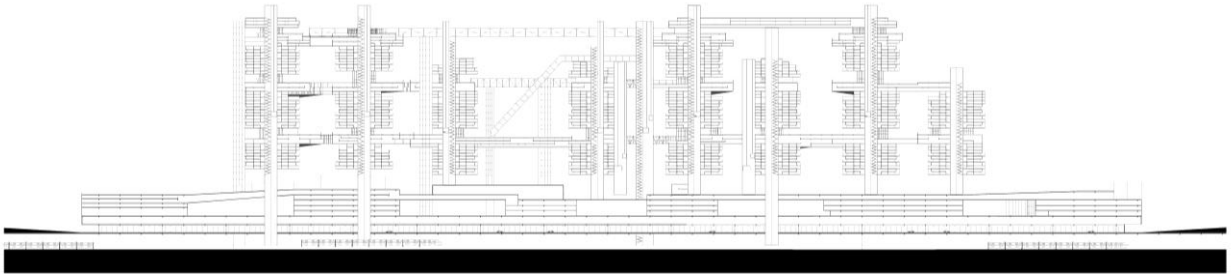


Figure 6.76: Sixth step, city start expansion in 5-10 years.

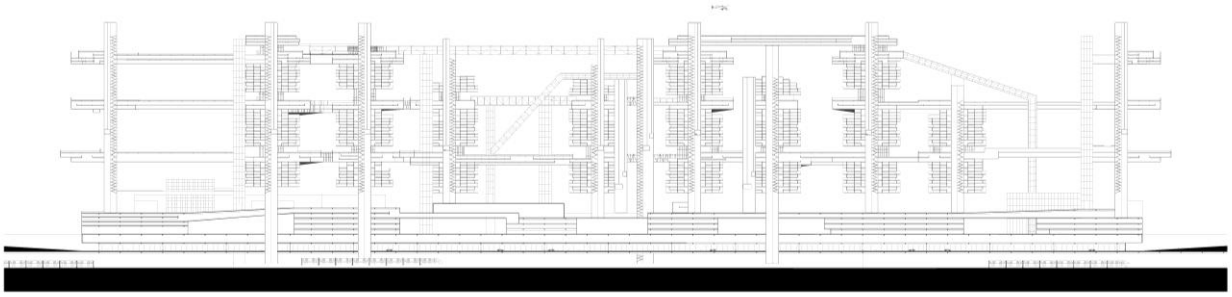


Figure 6.77: Seventh step, plug in new vertical and horizontal system, preparing for next step's expansion.

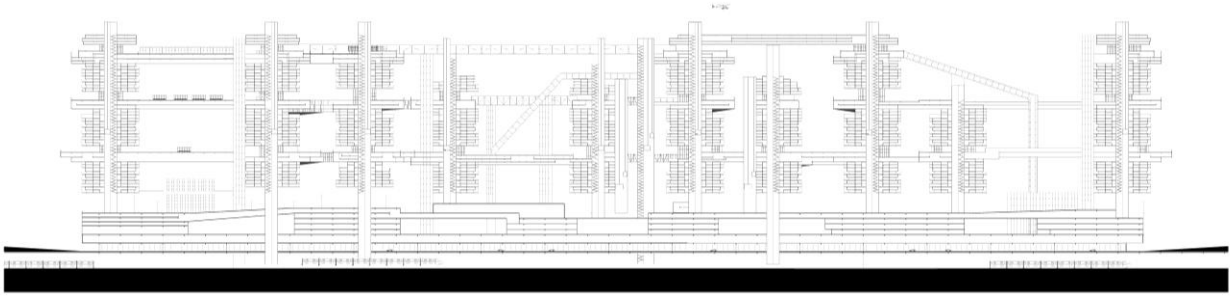


Figure 6.78: Eighth step, complete horizontal system.

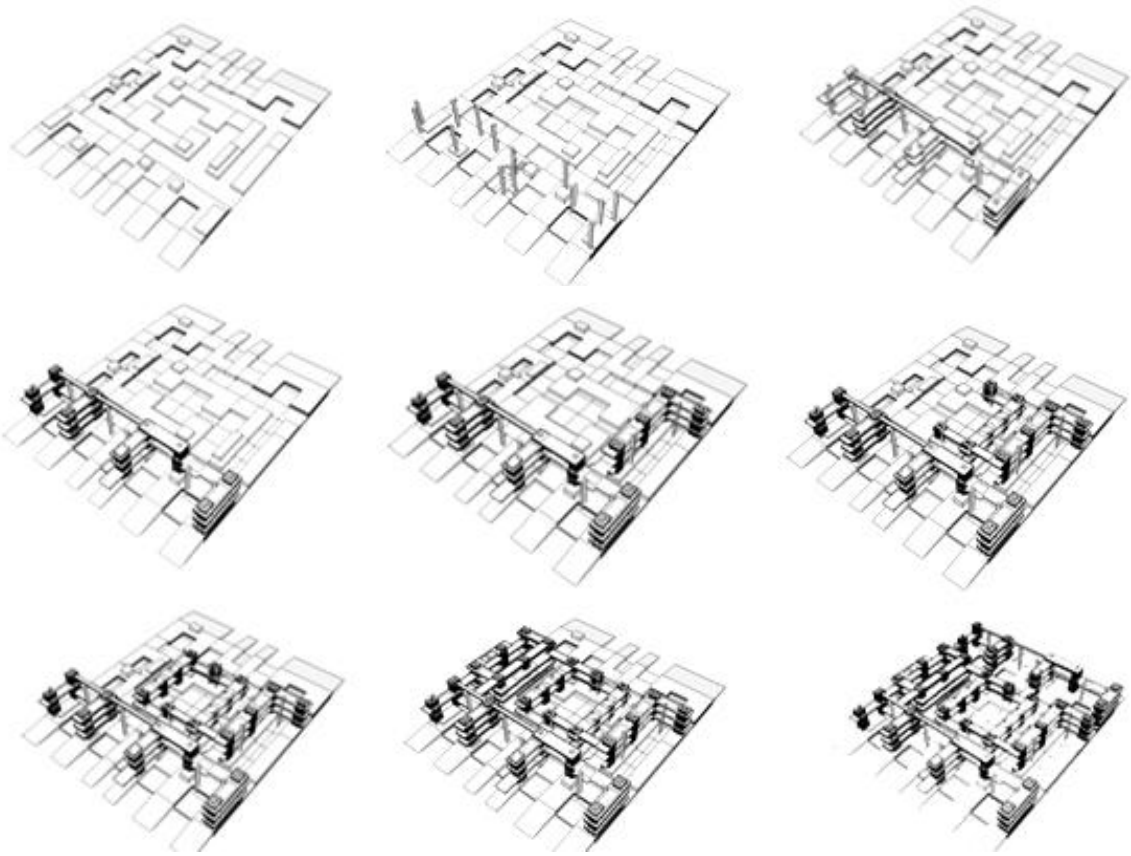


Figure 6.79: Perspective of construction process.

6.8 Ecology Consideration of Mega

6.8.1 Ecology Solutions

The architect and philosopher Paolo Soleri came up with the term "Archology" in the Acosanti. He wanted to build a 25-floor building, covering an area of 13 acres in the 860 acres of land accommodating 5000 people. The megastructure would provide all the necessary support system and the city self-operating. Although, the whole city is still in the first stage and has less than 100 people, it is still regarded as the first exploration in the megastructure.

The ecology of megastructure should be based on the following tips: First, it could provide a pleasant indoor space for human beings. It includes the temperature, humidity, healthy and clean air in a good light environment, acoustic environment and flexible and open space. Second, it should reduce the harm to environment in the use of natural resources. High density megastructure would save the land space. It would also reduce, reuse, and recycle renewable resources instead of non- renewable resources in the energy and material choice. Third, it

should minimize the impact on the environment, referring to reduce emissions and proper handling of hazardous waste materials and reduce light pollution and noise pollution.

Due to the high density of the architectural form and the huge building volume, Group-Form megastructure provides the possibility of vertical ecology: roof garden, vertical green and combination of high technology. At the same time, the activity radius is limited within the pedestrian distance, It would promote the pedestrian system and reduce the use of cars.

6.8.2 Roof Garden

As a part of a hierarchical ground, the roof of Group-Form megastructure would be used gardens, swimming pool and other amenities to improve the living conditions and thermal properties like the roof gardens of Marina Bay Sand. The Hanging Gardens of Babylon can be seen as the earliest example.

Roof gardens would be used in the urban agriculture. In today's society, the contradiction between the continuous reduction of cultivated land and increasing construction is more prominent. The roof could provide additional space for agricultural production to meet the food supply while having the city is close to nature with farming experience opportunities. Kurokawa's "agricultural city" is a manifestation and combination between megastructure and agricultural trends. Roppongi Hiruzu planted the rice and vegetables on the roof. Now the production made by the roof's rice has been a famous food to sell.

6.8.3 Vertical Greening

The Group-Form megastructure provides a relatively large surface area. While applying good use of the green environment, the formation is an important role, not only to watch thermal radiation effect but it would decreased to some degree. In south China, if the high-rise residential balcony could properly open up to some of the green areas, it is possible that climbing plants could be developed. The specific methods include vertical surface green garden or atrium. Ken Yeang, the Malaysia architect is the representation of this concept as seen in his buildings. In the design of Menara Boustead, he combined the green vegetation into the façade. And Kanchenhanga Apartments, designed by Charles Correa, set a courtyard on every other floor.

The concept of planting into the Group-Form megastructure can effectively

improve the local micro climate. In the mild climate of summer, the outer surface of a greening a building façade could reduce the temperature by than 5 ℃ street at ambient temperature and heat loss in winter reduced to 30%. The façade of megastructure is huge with proper use could be effective as the cooling effects. It is important to reduce the heat island effect in a city. The building facade can also be formed on the balcony, which by forming a continuous green area and ecological system could connect the ground as a whole. Vertical greening includes a garden in the air, except with the sunshade on the outside can increase air and improve the local micro climate. As a flexible space expansion, it could create a more humane environment.

6.8.4 Ecology Technology

The common ecological technology includes new energy such as solar energy, equipment and materials with low energy consumption such as high performance composite wall, hollow glass and the application of thermal insulation of windows and doors. It is recommended to use the recycle system of rain water and set the solar panel on the surface of megastructure. The heat pump is also an option. Masdar is a famous case which uses the modern technology. The architects claim that it would support itself after building it.

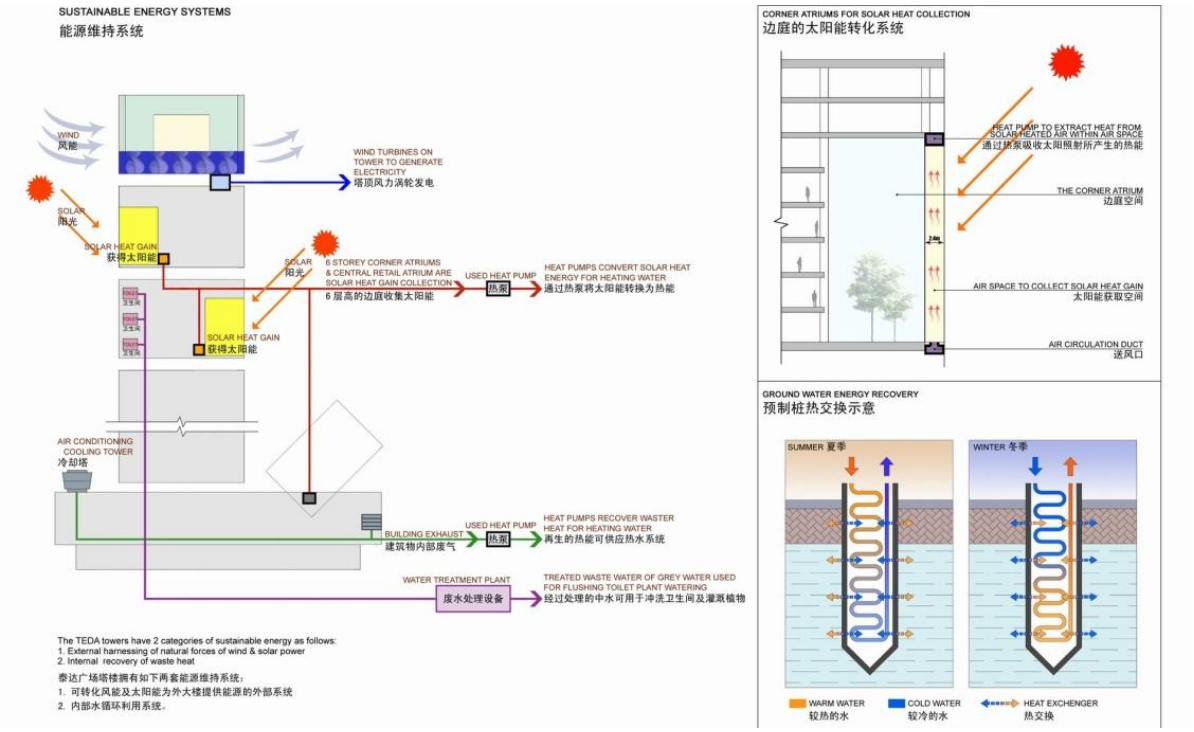


Figure 6.80: Sustainable energy systems, corner atriums for solar heat collection and ground water energy recovery.

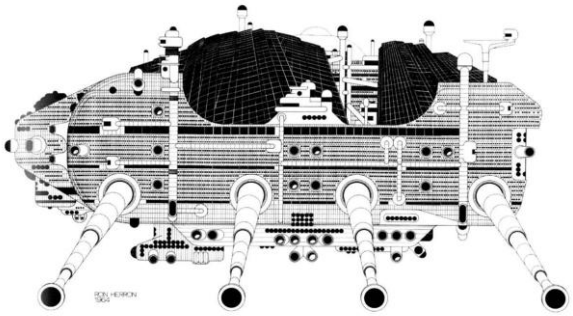
6.9 Future Thinking about Megastructure

The concepts of megastructure are based on the construction. As an aggressive proposition, it would need further thinking and imagination. As an organism, the megastructure would either into end or get a new update. In this chapter, it would involve the dismantling and removal of megastructure.

After a few years, if the megastructure cannot satisfy the surrounding environment, it needs to be dismantled. Because of high the density and complex of mega, the public cannot deal with a common mode. The existing modes are always blasting or abandoned. It would cause a huge waste of resource and ecological crisis. Once it is abandoned, the huge construction would become a huge hotbed of crime.

Figure 6.81: April 1972. The second, widely televised demolition of a Pruitt–Igoe building that followed the March 16 demolition

Throughout the early `60's and into the 20th century, the Archigram have proposed a concept of a "mobile city". As mentioned in the second chapter, they are no longer regarded as "permanent" structures but movable industrial products. Such as the Plug-in city, designed by Peter Cook in 1964, all the urban elements—such as residential units, office units, sidewalks and other facilities are designed as building blocks, which could be plugged into the interface. The Walking City proposed by Ron Herron in 1964 hoped the buildings could walk by the machine foot. They also developed the concept of "Instant city". This idea of the city is fixed with balloons. When the city needs to be relocated, the public could change the balloons to make the city move to another place. These ideas are crazy but they help provide the new solutions. The buildings or cities could be "nomadic. When the surrounding ecologic environment is not fit for the development of mega, it is no longer passive demise and could be moved to another place. In the process of moving, it even has the ability to become self-renewable.



Left: Figure 6.82: Instant City. Source: “The Real Instant City”. Right: Figure6.83: The Walking City, Ron Herron, 1964.

In the Future Bangkok Design of 2012, the author participated as part of the city’s function that moveable mass could be conducted by rail. This move is based on the traffic’s needs and renewing the cities.

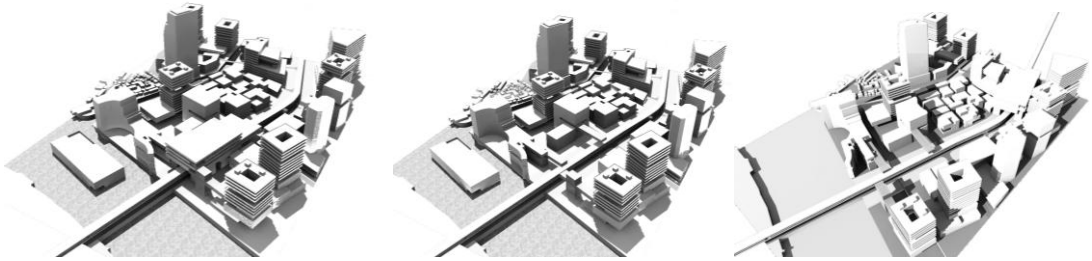


Figure 6.84: Moveable city in future Bangkok. Some parts of city could move around railway.

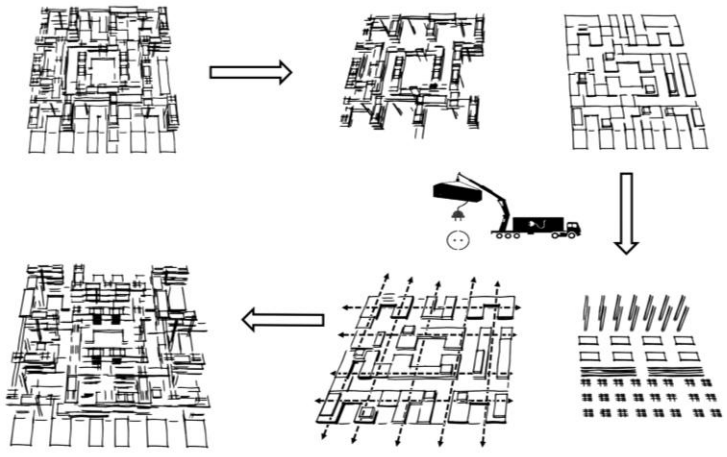


Figure 6.86: Moveable Group-Form Megastructure. The whole megastructure could be moved to another place.

The whole mega could be dived into 2 parts: upper half---vertical city and low half----downtown podium. The vertical city is made with the building blocks. The sky streets and residential units are made with certain modular unit. They are disassembles and moved to a designated destination through large traffic tools. The assembly process is referenced in the last chapter.

Although the city is connected through corridors podium with each other, we can dismantle the air connection system and divide it into several independent body blocks. Each block is like

a large body aircraft carrier: the lower part of the track and other mobile devices are fitted and moved. They can follow a trajectory re-moved to a new environment, re-rooted, and then assembled again for the construction of a new city to provide the necessary components for the giant structure.

It is the aspirations of this author that through this mode of operation, the mega is no longer a passive acceptance but an updated urban city that migrates and not extinction. It could also help with recycling initiatives.

Chapter 7 Epilogue

The thesis briefly summaries the history and development of megastrcture since Chicago School, from Alger's Plan of Le Corbusier (1930s) to systematic discussion of Megastructure by Fumihiko Maki (1960s), the series of ambitious imagination of megastructure by Archigram and Metabolists（1960-70s）, until Koolhas, Norman Foster and MVRDV's conceptual design presently, but there has hardly a pause on the dream in chasing megastructure. However, in reality, more case studies are just a utopia and no cases have come true. In the present time which mega is becoming a reality, exploration of design issues towards practice is needed.

Based on the case studies, the thesis divides the mega into two types: Integral --Form and Group-Form. Integral-Form Megastructure is the classic megastructure, but it is difficult to build because it is huge in scale. It is also difficult to ensure the safety of the people, especially during earthquake and fire. Compared to the former one, the Group-Form Mega is easier to build. The independent individuals guarantees the sunshine and ventilation and the success of group-form high rise buildings such as Modern MOMA support a stronger public interest. It could satisfy the public desire of "Great", minimize the conflict with the society's limit and design the space "vertical" and "diversity". We could regard the" Group-Form" Megastructure as a compromise form to the conceptual mega and it would most likely be built.

Then, it discusses related cases of Group-Form Megastructure from two possible configurations. First, it analyzes a series of high-density cases influenced by Group-Form Megastructure including contemporary MOMA (although they cannot be called a true megastructure from the perspective of scale), and researches on the design methods of Group-Form Megastructure. Secondly, according to three different density's towns, it involves the urban space system in different density.

By the abstract and transforming of traditional horizontal cities, the thesis build the urban space model of Group-Form Megastructure and put forward the design guidelines. They include:

1. Establishing a rich various urban space system by sky streets and secondary grounds, to provide diversity space for daily life. The sky streets and secondary grounds could be divided into 4 parts: neighborhood units, commercial units, entertainment units and other special units.

2. Establishment transportation system of megastructure: 3-4 horizontal circles are provided in the whole mega from top to bottom. The walk is encouraged as each circle could be walked through. The vertical transportation could be divided into three kinds: the normal ones, the express elevators which are directly to the public floors and slow elevators combining with

relaxation. They are connected to the ground, and the bottoms are even connected to the railway system.

3. Relevant changes of community's organization:

The neighborhood committee should return to the original neighborhood services unit, forming a management system of megastructure (specialized management committee) - neighborhood committee, which is more flat and crosswise.

4 Construction and renew in modular way. When the buildings are so large that the common methods could make sense, architects should use modular prefabricated assembly, with the industrialization of construction in the process of construction and urban renewal.

5 Ecological considerations: It includes roof gardens, vertical greening and ecology technology.

Megastructure has experienced one hundred's years' development. The author hope the thesis will help the megastructure become a reality in construction in future,

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The group high rise buildings lack the horizontal connections or the connections are underground or on ground. In the Group-Form Megastructure, the horizontal connections are very important parts and they could exist both on the bottom and in the sky. Source: Made by the Xu Yang.

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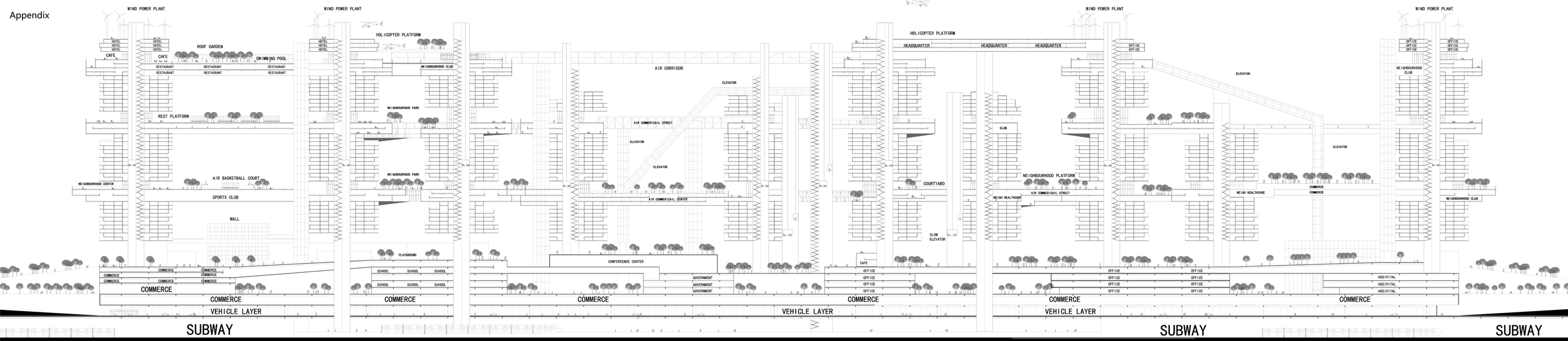
Appendix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